

LEVEL 4 ASSESSMENT SPECIFICATION

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Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission, you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

LO1, LO2

TASK DESCRIPTION

This Assignment consists of THREE sections: A, B and C.

Commercial Marketing Office Installation

Specification

The attached drawing shows the plans for a Marketing Office on the ground floor of a four-storey office building.

- The offices have been refurbished in recent years and the interior walls are 100mm solid partition sections.
- External walls are of 225mm brickwork, internally plastered.
- The office floors have been screeded and are to be covered with carpet tiles.
- The roof/ceiling construction is as shown on the detailed drawing attached.

Electrical Supply Details

- The electrical supply to the building is TNC-S 400V, 3-phase and Neutral.
- The installation within the building is fed by a variety of final circuits plus a sub-main SWA cable to the office suite.
- There is an existing single phase, 10way, double insulated consumer unit with BS3036 protective devices installed by the entrance to the office area. The supply to the unit is TN-S, 230V, 50Hz, single-phase.
- The quick start modular fluorescent luminaires are rated at 58W.
- The tungsten filament lamps are rated at 100W

The mounting heights of the accessories above finished floor level (f.f.l.) are as follows:

- Light switches 1200mm
- Switched socket outlets 450mm
- Distribution board 2100mm

All work is to be carried out during normal working hours and while the rest of the building is occupied.

Section A

1. The client has requested that level of illumination within the marketing and Administration offices is to be upgraded by substituting the single 1500mm 58W luminaires with 1800mm twin lamp fittings rated at 70W per lamp.
Explain the likely effects the change will have upon the rating of the circuit cables and protective devices
2. The partition between the manager's office and the manager's secretary's office is to be relocated 30 inches into the secretary's office.
 - a. Identify the ramifications in terms of electrical work
 - b. Explain what would be required between the various trades/ contractors working in such a small area
 - c. Identify how (b) above, would be achieved
3. List the factors to be considered when calculating the costs of
 - a. Upgrading of fluorescent luminaires
 - b. Removal and replacement of outlets within the partition
 - c. Upgrading the lighting to modern installation standards
 - d. Upgrading the consumer unit to current requirements

Section B

4. Due to the electrical loading for this building, the supplier's equipment has current transformers (CTs) installed as part of the metering arrangement. With the aid of a sketch, show how such CTs would be installed and connected
5. Upon completion of the alterations and additions to the electrical installation, the work will have to be inspected and tested following which it must be certificated
Describe the:
 - a. Testing that will need to be carried out
 - b. Standards to which the test equipment and leads must comply
 - c. IET publication which gives guidance on the inspection, testing and certification of electrical installationsand state the
 - c. Certification forms which must be completed
 - d. Report work which will need to be completed referring to the existing installation
 - e. Person who should receive the completed forms
6. State the types and ranges of test instruments which will be used to test this electrical installation
7. Research and state the maximum permitted values of earth fault loop impedance for the lighting and socket outlet circuits in the office area

Section C

8. Consider a way in which the entire lighting system in the offices and general work area can be switched by the operation of one Key Switch located by the front door. Create and label a wiring diagram to illustrate the interconnection of the control components within circuit
9. State three possible causes of the non-operation of a fluorescent luminaire within the office area and suggest how you would rectify each
10. State the implications of isolating the supply to the office once it has been occupied by the client
11. With the aid of a fully labelled circuit diagram, show how it is possible to provide a 400V three-phase, four wire supply from an 11kV, three phase, three wire supply
12. Indicate on a circuit diagram how the following supplies are connected on a three phase four wire TN-S system:
 - a) 230Volts single-phase
 - b) 400V, three-phase, three-wire
 - c) 400V, three-phase, four wire

Commercial Office Installation

Electrical Installation

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Introduction

This assignment consists of three sections: A, B, and C. The assignment will explain the construction, installation and testing of the electrical systems that are requested by the client for the office building.

Section A

1.

By substituting 1500mm 58W luminaires with 1800mm twin lamp fittings rated at 70W each, the light output will be drastically increased, this will also result in increased power consumption. The calculations for power consumption are presented below.

Current Consumption

$$\text{number of lamps} \times \text{lamp rating} = \text{power consumption}$$

$$8 \times 58 = 464W$$

To calculate the amount of energy through the circuit and evaluate protection.

$$464 \div 230 = 2.02A$$

This gives a rating of just over 2A. **Table 1**, column three shows that a 1.0mm² cable has a CCP (current carrying capacity) of 10.5, meaning that the current 1.0mm² cable will be of acceptable c.s.a (cross-sectional area) to cope with this current demand. The circuit is also sufficiently protected by the BS3036 Fuse which is a 5A rewirable fuse.

CURRENT-CARRYING CAPACITY (amperes) and
VOLTAGE DROP (per ampere per metre):

Ambient temperature: 30°C
Conductor operating temperature: 70°C

Conductor cross-sectional area	Method 100# (above a plasterboard ceiling covered by thermal insulation not exceeding 100mm in thickness)	Method 101# (above a plasterboard ceiling covered by thermal insulation exceeding 100mm in thickness)	Method 102# (in a stud wall with thermal insulation with cable touching the inner wall surface)	Method 103# (in a stud wall with thermal insulation with cable not touching the inner wall surface)	Reference Method A* (enclosed in conduit in an insulated wall)	Reference Method B* (enclosed in conduit on a wall or in trunking etc)	Reference Method C* (clipped direct)	Voltage drop (per ampere per metre)
1	2	3	4	5	6	7	8	8
(mm ²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(mV/A/m)
1	13	10.5	13	8	11.5	13	16	44
1.5	16	13	16	10	14.5	16.5	20	29
2.5	21	17	21	13.5	20	23	27	18
4	27	22	27	18.5	26	30	37	11
6	34	27	35	23.5	32	38	47	7.3
10	45	36	47	32	44	52	64	4.4
16	57	46	63	42.5	57	69	85	2.8

A* - For full installation method refer to Table 4A2 Installation Method 2 but for flat twin and earth cable

C* - For full installation method refer to Table 4A2 Installation Method 20 but for flat twin and earth cable

100# - For full installation method refer to Table 4A2 Installation Method 100

101# - For full installation method refer to Table 4A2 Installation Method 101

102# - For full installation method refer to Table 4A2 Installation Method 102

103# - For full installation method refer to Table 4A2 Installation Method 103

Wherever practicable, a cable is to be fixed in a position such that it will not be covered with thermal insulation.

Regulation 523.9, BS 5803-5: Appendix C: Avoidance of overheating of electric cables.

Building Regulations Approved Document B and Thermal insulation: avoiding risks, BR 262, BRE, 2001 refer.

Table 1 - Table 4D5 - 70C thermoplastic Insulated and sheathed flat cable with protective conductor COPPER CONDUCTORS
(The Institution of Engineering and Technology, 2022)

Substituted Consumption

The lamp rating of the substituted lamps are twin lamps, each rated at 70W, therefore the calculation will be using 140W ($2 \times 70 = 140$)

$$8 \times 140 = 1120W$$

$$1120 \div 230 = 4.87 \approx 4.9A$$

These lights are fluorescent bulbs, which require an inrush current to allow the ballast to ignite the tubes light. After the inrush current, the current settles. The current rating has to be calculated with the correction factor which equals 1.8.

$$4.9 \times 1.8 = 8.82 \approx 9A$$

The 5A fuse is now insufficient for the supply, as is the cable. 10 A protection devices are to be installed, and RSCBOs protected by RCDs, a 10A MCB protecting the circuit will also be suitable. Additionally, the unit could be replaced for a metal clad CCU. Upgrades to the cable would be necessary to manage the load as the tubes age, older tubes require more current for the ballast to ignite the gas. Reviewing **Table 1**, a 1.5mm² has a CCP of 13A which is sufficient to avoid tripping due to excess overload.



Figure 1 - MK Sentry 21 Module 13 Way Fully Populated Dual RCD Metal Consumer Unit with 100A Main Switch (MK Sentry, undated)

All these implementations and upgrades will add to the cost, there could also be further jointing if relocating lights. In order to keep costs low by reducing all the rewiring and to bring up to date, LED lights could be installed. Installing LED lights would be more cost effective as they output similar light and there would be no need to install new fuses, LEDs would be strongly advised to the client.

2.

a)

To relocate the managers and secretary office partition, the partition itself will first have to be removed and rebuilt. Before the carpenter can come in and remove the wall, the electrician has to remove the two gang switched socket outlets one from each office, the electrician will

isolate then disconnect the sockets. This will have to be communicated with the manager and secretary as they may be unable to access power in their offices for the time being. Once the carpenter removes the partition, find the wires and remove them. Identify where the wires will go for the new partition, once planned out, pull in new wires. Once the new wall is plastered, the sockets can be refitted, reconnected, and tested. The electrician must test isolation resistance, R1+R2 continuity, insulation resistance between phase and earth, and resistance of fault path back to distribution board. In addition to this, the fluorescent light fitting in the secretary room will also need to be relocated closer to the second florescent light In the secretary office.

b)

Due to the complexity of the job, several trades will be required to complete the job, and because work is to be carried out during normal working hours, the confined space may make it difficult for contractors to carry out the work. Clear and effective communication will be required.

c)

At times there may be several trades people working inside the confined area, in order to counteract this, cooperation and communication between the contractors is vital. Holding regular meetings, discussing, and planning jobs and times would ease the congestion of workers, and would allow everyone involved to know the stage of the job and when they can carry out work that is required.

3.

a)

There are a number of costs associated with the upgrade of fluorescent lights, these include:

- Cost of replacement (fitting new luminaires)
- Labour costs
- Material Costs
- Rewiring, future proofing with larger amperage rated circuit.
- Costs could rise due to inadequate/aging infrastructure.
- Design costs

b)

Costs associated with the removal and replacement of outlet in partition:

- Cost of replacement (socket removal, fitting back into replacement)

- New cables, pulling in new cables.
- Down time, waiting for other contractors to complete work.
- Removing old cables (markup of old equipment and disposal)
- Labour costs

c)

Costs associated with upgrading lighting:

- Upgrade of lights (newer options that could require retrofitting)
- Options of LED lighting that may output more light.
- New accessories
- New fittings, might require plasterwork to fit to a new location.

d)

Costs associated with upgrading lighting:

- Protection: MCBs (miniature circuit Breakers), RCDs (Residual Circuit Devices)
- New distribution board (switch board)
- New cabling

Section B

4.

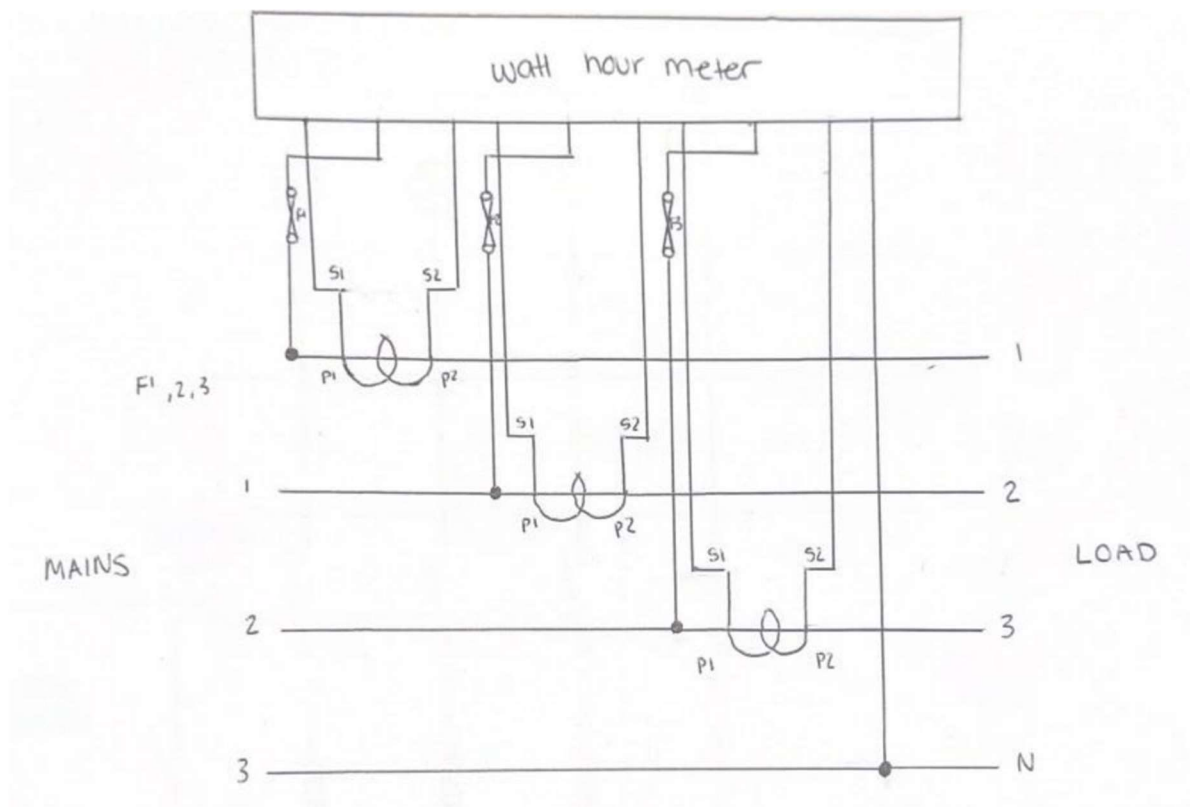


Figure 2 - Shows the metering arrangement with the CT supply.

This arrangement is important to form a connection between the supply and customer switches. All incoming cables will be housed inside the meter entering from the bottom.

5.

a)

Upon completion, several checks will be carried out to test the installation, tests will include:

- Testing and inspection of upper floor installation (circuit wired and connected)
- Continuity of protective conductors
- Continuity of ring final circuit
- Insulation resistance of every cable
- Earth fault loop impedance
- Prospective fault current
- RCD testing
- Continuity of every conductor (R1 to R1, R2 to R2, Rn to Rn)
- Socket outlets (when testing, the flow resistance Ohmmeter reading should be the same at all sockets, one quarter of sum of line and neutral loop resistance.
- Polarity (Testing that resistance in path for earth fault is low enough for its transmission to ensure protective devices operate correctly.

b)

Testing equipment must meet and comply with specific standards to ensure correct operation. All testing equipment must comply to BS EN 61010 – Safety Requirements for Electrical Equipment for Measurements, Control and Laboratory use. In addition, guidance GS 38 covers Electrical test equipment for use on low voltage electrical systems is aimed at electricians using electrical testing equipment.

Test equipment

Test probes, clips and leads

9 The test probes, clips and leads used in conjunction with electrical test equipment should be selected to prevent danger. Modern test probes, clips and leads should:

- conform to the requirements of BS EN 61010-031 or in the case of a 2-pole voltage detector to BS EN 61243-3 (see Further reading);
- be marked with the rated installation category – CAT II, III, or IV;
- be marked with the manufacturer's name or identifying mark; and have the following:
 - probes, and clips, which:
 - o have finger barriers or are shaped to guard against inadvertent hand contact with the live conductors under test;
 - o are insulated to leave an exposed metal tip not exceeding 4 mm measured across any surface of the tip. Where practicable it is strongly recommended that this is reduced to 2 mm or less, or that spring-loaded retractable screened probes are used;
 - o when used with a multimeter, should have suitable high-breaking capacity (hbc), sometimes known as hrc, fuse, or fuses,[†] with a suitable current rating (usually not exceeding 500 mA), except when used with a loop impedance or RCD tester where a value of 10 A is typically used or a current-limiting resistor and a fuse.^{**}

Figure 3 – Test Equipment Standards (Health and Safety Executive, 2015)

GS 38 states that test probes must have finger barriers, and that the test probes must have no more than 4mm uncovered tip, however 2mm is recommended. The Testing equipment cases must be complete and not cracked or damaged. Any spring-loaded retractable covers for probes must be functioning, if damaged or not functioning as desired, they must not be used.

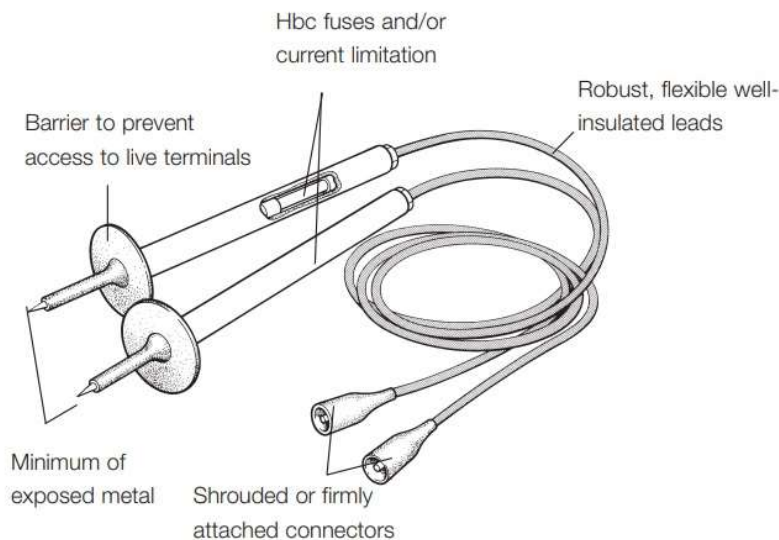


Figure 4 - Recommended Type of Test probes and Leads (Health and Safety Executive, 2015)

c)

IET Guidance Note 3: Inspection & Testing 9th Edition is the latest edition of the “guidance book for all those involved with the testing and inspection of electrical installations.” (The Institution of Engineering and Technology, 2022) These guidance notes give in depth procedures to carry out and complete when testing and inspecting electrical installations.

d)

There are several forms and certificates that must be completed in order to ensure the equipment is installed correctly and is in safe working condition. “I-certs, are test certificates produced by a registered electrician to confirm that they’ve tested and approved that the wiring work in an installation is safe and complies with the BS 7671 standards” (RS, 2023) According to BS 7671:2018+A2:2022 by Institute of Engineering and Technology, model forms for certification and reporting are listed below:

- Electrical Installation Certificate (EIC)
- Minor Electrical Installation Works Certificate (MEIWC)
- Electrical Installation Condition Report (EICR)
- Schedule of Inspections
- Schedule of Circuit Details
- Schedule of Test Results

e)

The form that needs to be completed for the office and main admin area will be an EICR. The report includes the inspection and test results and should state the recommended date the next EICR should be completed by.

f)

The person to receive the completed forms is the client, the person who ordered the work to be carried out in the office it would be the owner or secretary.

6.

The testing instruments to be used are listed below:

- Multifunction tester with individual test equipment
- RCD tester
- Low- resistance ohmmeter with a range of 0-20Ω.
- Insulation resistance tester with a range of 0-250MΩ.
- Earth fault loop impedance tester with PFC test facility 0-2000Ω
- PFC (Perspective Fault Current) tester 0-20,000A
- Approved voltage tester with proving unit.



Figure 5 - Martindale VIPD150 Voltage Indicator & Proving Device kit (Thorne & Derrick International, 2014)

For safe installation procedure an approved voltage tester with proving unit, provides a known source to prove the circuit is dead.

7.

Earth fault loop impedance is the path taken by the fault current when a low impedance fault happens between the phase conductor and earth. It is important to ensure continuity of circuit protective conductors which protects people from becoming earth fault paths. Earth fault path has to function in order for the path to go the correct way, this is to the source of supply. Fault protection is provided by protective earthing, protective bonding, and automatic disconnection if a fault occurs. If there is a fault, it will follow a path back through the CPC to the transformer back into the protective device that will switch off in order to protect the internal final circuit. This is why maximum permitted value of resistance in main earthing is 0.05Ω , a very low value which allows current to flow easier creating the earth fault impedance path.

The calculation for earth fault loop impedance is presented below:

$$Z_s = Z_e + (R_1 + R_2)$$

Where Z_s is maximum earth fault loop impedance

Z_e is external impedance

R_1 is Line conductor impedance.

R_2 is protective conductor impedance.

This equation can be broken down into two areas: Z_e is related to the external area to the installation and $(R_1 + R_2)$ is the area internal to the insulation.

Flow resistance ohmmeter can be used to test continuity. Dead test means there's no electricity present apart from the 6V from the Ohmmeter.

**TABLE 41.1 –
Maximum disconnection times**

System	50 V < U ₀ ≤ 120 V		120 V < U ₀ ≤ 230 V		230 V < U ₀ ≤ 400 V		U ₀ > 400 V	
	(s)		(s)		(s)		(s)	
	AC	DC	AC	DC	AC	DC	AC	DC
TN	0.8	NOTE 1	0.4	1	0.2	0.4	0.1	0.1
TT	0.3	NOTE 1	0.2	0.4	0.07	0.2	0.04	0.1

Where in TT systems the disconnection is achieved by an overcurrent protective device and the protective equipotential bonding is connected with all extraneous-conductive-parts within the installation in accordance with Regulation 411.3.1.2, the maximum disconnection times applicable to TN systems may be used.

U₀ nominal AC rms or ripple-free DC line voltage to Earth.

Where compliance with this regulation is provided by an RCD, the disconnection times in accordance with Table 41.1 relate to prospective residual fault currents significantly higher than the rated residual operating current of the RCD.

Table 2 - Maximum disconnection Time (The Institution of Engineering and Technology, 2022, p.59)

The correct disconnection time can be found using **Table 2** above, the office is TN supplied therefore the maximum disconnection time for the office is 0.4seconds. This information can be used to be able to find the maximum earth fault loop impedance

**TABLE 41.3 –
Maximum earth fault loop impedance (Z_s) for circuit-breakers with U₀ of 230 V, for operation giving compliance with the 0.4 s disconnection time of Regulation 411.3.2.2 and 5 s disconnection time of Regulation 411.3.2.3 (for RCBOs see also Regulation 411.4.204)**

(a) Type B circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1													
Rating (amperes)	3	6	10	16	20	25	32	40	50	63	80	100	125
													I _n
Z _s (ohms)		7.28		2.73		1.75		1.09		0.69		0.44	
	14.57		4.37		2.19		1.37		0.87		0.55		0.35
													230 x 0.95/(5I _n)
(b) Type C circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1													
Rating (amperes)		6	10	16	20	25	32	40	50	63	80	100	125
													I _n
Z _s (ohms)		3.64		1.37		0.87		0.55		0.35		0.22	
			2.19		1.09		0.68		0.44		0.27		0.17
													230 x 0.95/(10I _n)
(c) Type D circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1													
Rating (amperes)		6	10	16	20	25	32	40	50	63	80	100	125
													I _n
Z _s (ohms)		1.82		0.68		0.44		0.27		0.17		0.11	
0.4 sec			1.09		0.55		0.34		0.22		0.14		0.09
													230 x 0.95/(20I _n)
Z _s (ohms)		3.64		1.37		0.87		0.55		0.35		0.22	
5 secs			2.19		1.09		0.68		0.44		0.27		0.17
													230 x 0.95/(10I _n)

Table 3 - Maximum earth fault impedance for circuit breakers with U₀ of 230V, for operation giving compliance with the 0.4s disconnection time (The Institution of Engineering and Technology, 2022, p.62)

As show in **Table 3** above, the maximum earth fault loop impedance for a Type B circuit breaker used in the installation of the office is 4.37 ohms. This is the value of the maximum impedance of the circuit so the protective device would trip within 0.4 seconds.

Section C

8.

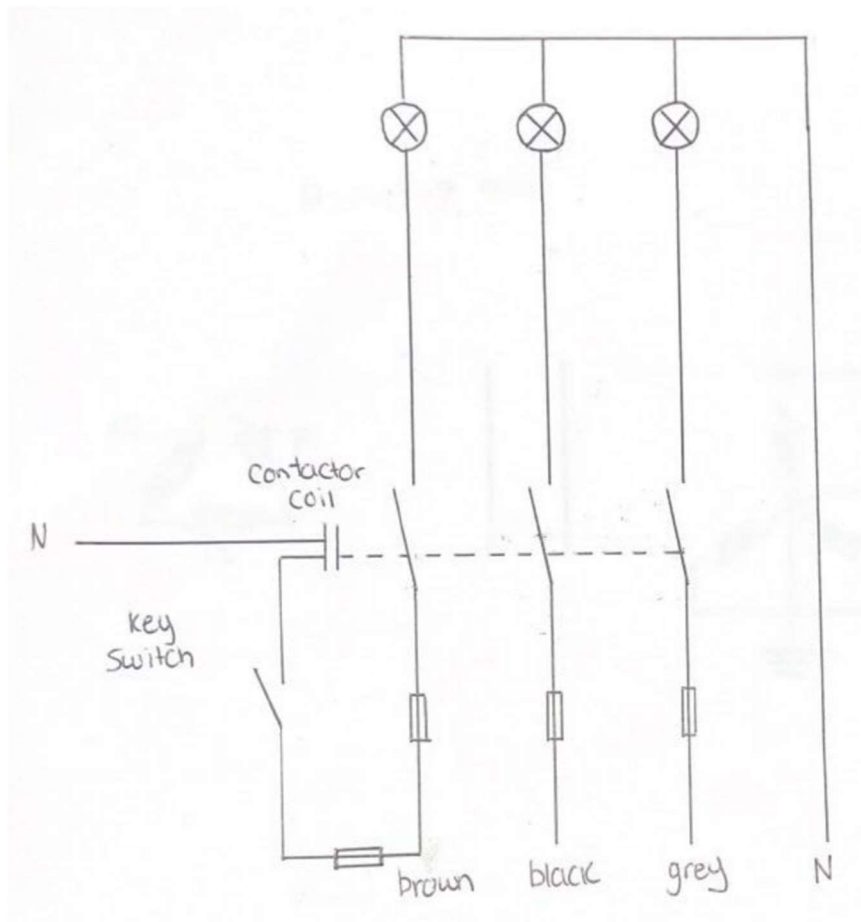


Figure 6 – Key Switch Diagram.

When the key switch is applied it energises the solenoid and the contactors. When the contactor closes the lamps turn on

9.

Non-operation of a fluorescent luminaire could be due to the starter module in the fluorescent light fitting. The starters are used to aid the fluorescent luminaires ignite when turned on. in order to fix this, the starter must be replaced, the starter module is usually located on the outside of the panel and is easily installed, this is an inexpensive and immediate fix.

A ballast is wired in series with a circuit and limits current passing through to prevent the bulb burning out. The ballast allows the circuit a boost of voltage to start the light and then a steady supply to keep it running. The “ballast system limits the current and then also limits voltage. This wattage control allows the light to build up very quickly but prevents overshoot, which would reduce the life of the bulb.” (Denton, 2009, p.301) If the ballast is dead, it would need to be replaced. To replace, turn off the power on the CCU, remove the tubes and back panel. Locate the ballast and with a non-contact voltage tester, ensure there is no voltage in the

wires. Cut the wires and remove ballast, put in new ballast stripping the insulation from wires and wiring the circuit up to replicate what it was previously. Put back the back plate and the tubes and switch on the power in the CCU.



Figure 7 - (Thiele, 2023)

Another component to check is the bulbs electrode, it has one each end of the tube and has 2 pins sticking out of it that help it fit into the light fixture. You can tests the electrodes by testing across them, if there is continuity then the electrodes are working, however the bulb still might not light for a number of reasons one of which could be that the gas has leaked from the tube, if this is the case and the electrode appears functioning then it may be time to replace the tubes. The issue could also be down to a blown fuse or damaged wires, it would be beneficial to test the contacts too, and inspect for any signs of damage. Tun off the power at the CCU, remove the back plate and test for voltage in the fixtures input, if no voltage is detected, inspect the wires check for damages, and replace if necessary, make sure all connections are in good condition.

10.

It is important to maintain effective communications with the office employees and let them know when work is to take place, and pre-plan visits to ensure the employees are ready for the work that is to take place. Stages of the installation will require isolating the supply of the office building, it is important to le the employees know as they will need to save any information on computers and power them off, if supply id cut off without warning, the office could lose sensitive information. Preplanning visits would let the business know if they won't be operating and if left without a generator or back up power supply, the business won't be able to function and would be forced to take down time which would impact business.

11.

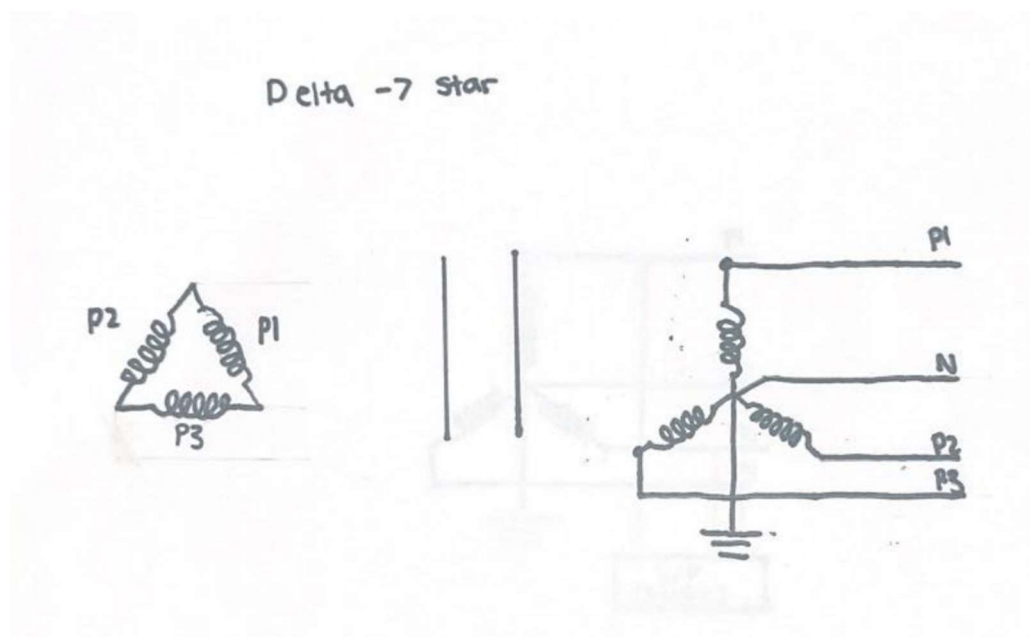


Figure 8 - Delta to Star Diagram

Delta to star 11kV three phase three wire supply to 400V three phase, four wire supply.

12.

a)

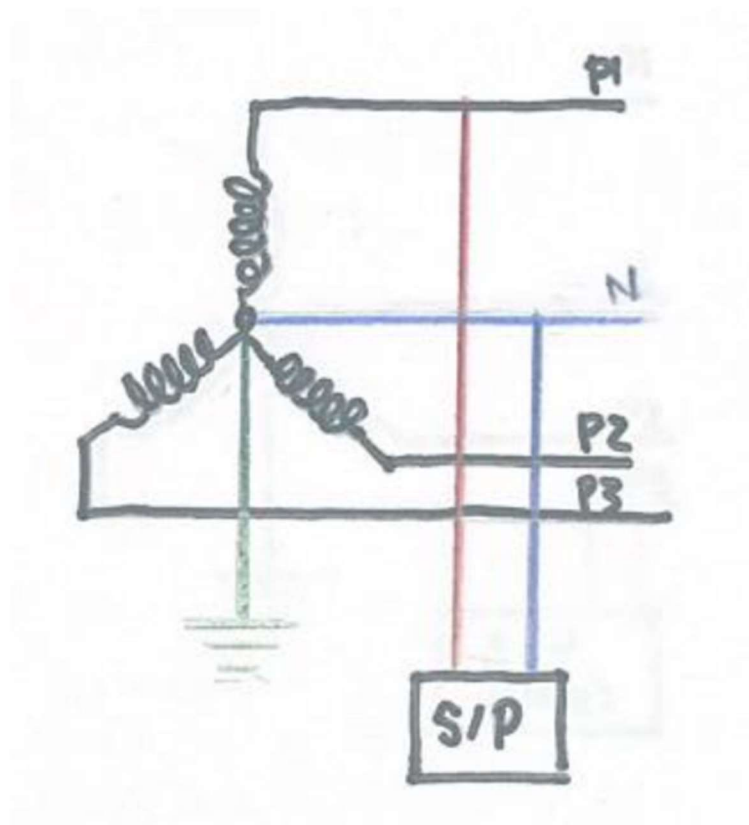


Figure 9 - 230 V single phase supplies connected on a three phase four wire TN-S system.

b)

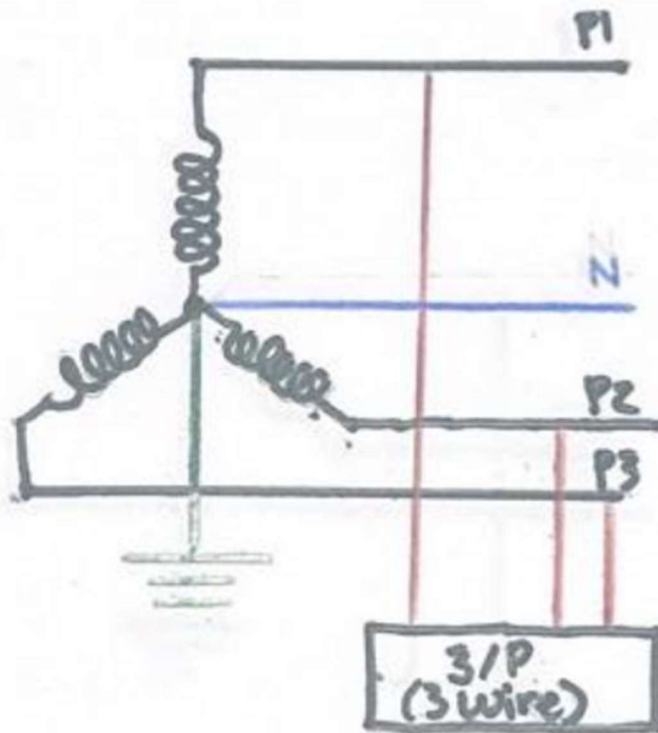


Figure 10 - 400V, three-phase, three-wire connected on a three-phase, four wire system

c)

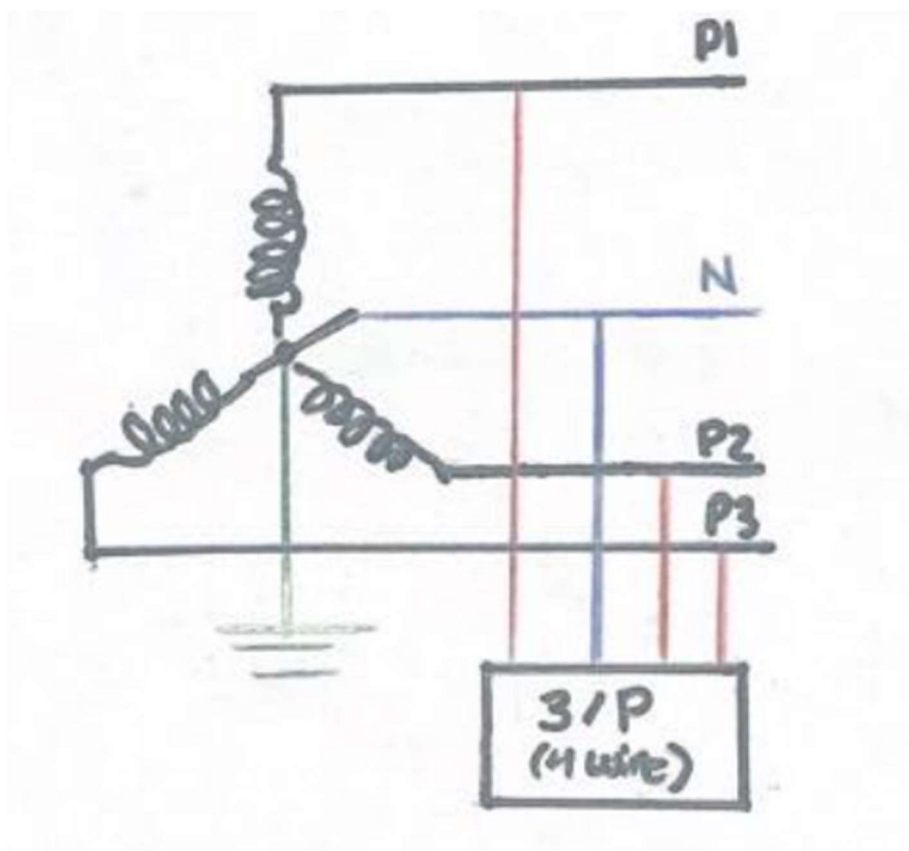


Figure 11 - 400V, three-phase, four wire connected to a three phase four wire TN-S System

Bibliography

- British Standards Institute (2023) *BS EN IEC 61010-031:2023 - TC Safety requirements for electrical equipment for measurement, control, and laboratory use - Safety requirements for hand-held and hand-manipulated probe assemblies for electrical test and measurement*, BSOL British Standards Online. Available at: <https://bsol.bsigroup.com/PdfViewer/Viewer?pid=000000000030411653> (Accessed: 21 December 2023).
- Denton, T. (2009) *Automobile Electrical and Electronic Systems*. 1st edn, ProQuest Book Central. 1st edn. Routledge. Available at: <https://ebookcentral.proquest.com/lib/pembrokeshire-ebooks/reader.action?docID=3060611> (Accessed: 10 January 2024).
- Health and Safety Executive (2015) *Electrical Test Equipment for Use on Low Voltage Electrical Systems*. 4th edn, Health and Safety Executive. Available at: <https://www.hse.gov.uk/pubns/priced/g38.pdf> (Accessed: 16 December 2023).
- MK Sentry (no date) *MK Sentry Catalogue*. Available at: https://assets.cef.co.uk/downloads/pdg/mk_ys8678smet_datasheet/mk_ys8678smet_datash eet.pdf (Accessed: 05 January 2024).
- RS (2023) *Electrical Installation Certificates Overview, Electrical Installation Certificate Guide*. Available at: <https://uk.rs-online.com/web/content/discovery/ideas-and-advice/electrical-installation-certificates-guide> (Accessed: 21 December 2023).
- Scaddan, B. (2018) *IET Wiring Regulations: Design and verification of electrical installations*. 9th edn, ProQuest Ebook Central. 9th edn. CRC Press LLC. Available at: <https://ebookcentral.proquest.com/lib/pembrokeshire-ebooks/reader.action?docID=5508482&query=bs7671> (Accessed: 28 December 2023).
- The Institution of Engineering and Technology (2022) *Requirements for electrical installations: IET Wiring Regulations: BS7671:2018*. 18th edn. London, United Kingdom: The Institution of Engineering and Technology.
- The Institution of Engineering and Technology (2022) *BS 7671:2018+A2:2022 MODEL FORMS FOR CERTIFICATION AND REPORTING*, <https://electrical.theiet.org/media/2822/bs7671-all-forms-v31.pdf>. Available at: <https://electrical.theiet.org/media/2822/bs7671-all-forms-v31.pdf> (Accessed: 21 December 2023).

The Institution of Engineering and Technology (2022) *Guidance Note 3: Inspection & Testing*. 9th edn. The Institution of Engineering and Technology. Available at: <https://shop.theiet.org/guidance-note-3-inspection-testing-9th-edition> (Accessed: 18 December 2023).

Thorne & Derrick International (2014) *Martindale VIPD150 Voltage Indicator & Proving Device kit*, Thorne & Derrick International. Available at: <https://www.powerandcables.com/product/electrical-test-equipment/martindale-vipd150-voltage-indicator-proving-device-kit/> (Accessed: 05 January 2024).

Citations

- Denton, T. (2009) *Automobile Electrical and Electronic Systems*. 1st edn, ProQuest Book Central. 1st edn. Routledge. Available at: <https://ebookcentral.proquest.com/lib/pembrokeshire-ebooks/reader.action?docID=3060611> (Accessed: 10 January 2024).
- Health and Safety Executive (2015) *Electrical Test Equipment for Use on Low Voltage Electrical Systems*. 4th edn, Health and Safety Executive. Available at: <https://www.hse.gov.uk/pubns/priced/gs38.pdf> (Accessed: 16 December 2023).
- MK Sentry (no date) *MK Sentry Catalogue*. Available at: https://assets.cef.co.uk/downloads/pdg/mk_ys8678smet_datasheet/mk_ys8678smet_datasheet.pdf (Accessed: 05 January 2024).
- RS (2023) *Electrical Installation Certificates Overview, Electrical Installation Certificate Guide*. Available at: <https://uk.rs-online.com/web/content/discovery/ideas-and-advice/electrical-installation-certificates-guide> (Accessed: 21 December 2023).
- The Institution of Engineering and Technology (2022) *Requirements for electrical installations: IET Wiring Regulations: BS7671:2018*. 18th edn. London, United Kingdom: The Institution of Engineering and Technology.
- The Institution of Engineering and Technology (2022) *BS 7671:2018+A2:2022 MODEL FORMS FOR CERTIFICATION AND REPORTING*, <https://electrical.theiet.org/media/2822/bs7671-all-forms-v31.pdf>. Available at: <https://electrical.theiet.org/media/2822/bs7671-all-forms-v31.pdf> (Accessed: 21 December 2023).
- The Institution of Engineering and Technology (2022) *Guidance Note 3: Inspection & Testing*. 9th edn. The Institution of Engineering and Technology. Available at: <https://shop.theiet.org/guidance-note-3-inspection-testing-9th-edition> (Accessed: 18 December 2023).
- Thorne & Derrick International (2014) *Martindale VIPD150 Voltage Indicator & Proving Device kit, Thorne & Derrick International*. Available at: <https://www.powerandcables.com/product/electrical-test-equipment/martindale-vipd150-voltage-indicator-proving-device-kit/> (Accessed: 05 January 2024).

Appendix

ASSIGNMENT 1

ELECTRICAL INSTALLATION LEGEND



KEY SWITCH and CONTACTOR



² 2 – GANG SWITCHED SOCKET OUTLET



1 – GANG TWO-WAY SWITCH



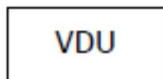
DISTRIBUTION BOARD



TUNGSTEN PENDANT LAMP



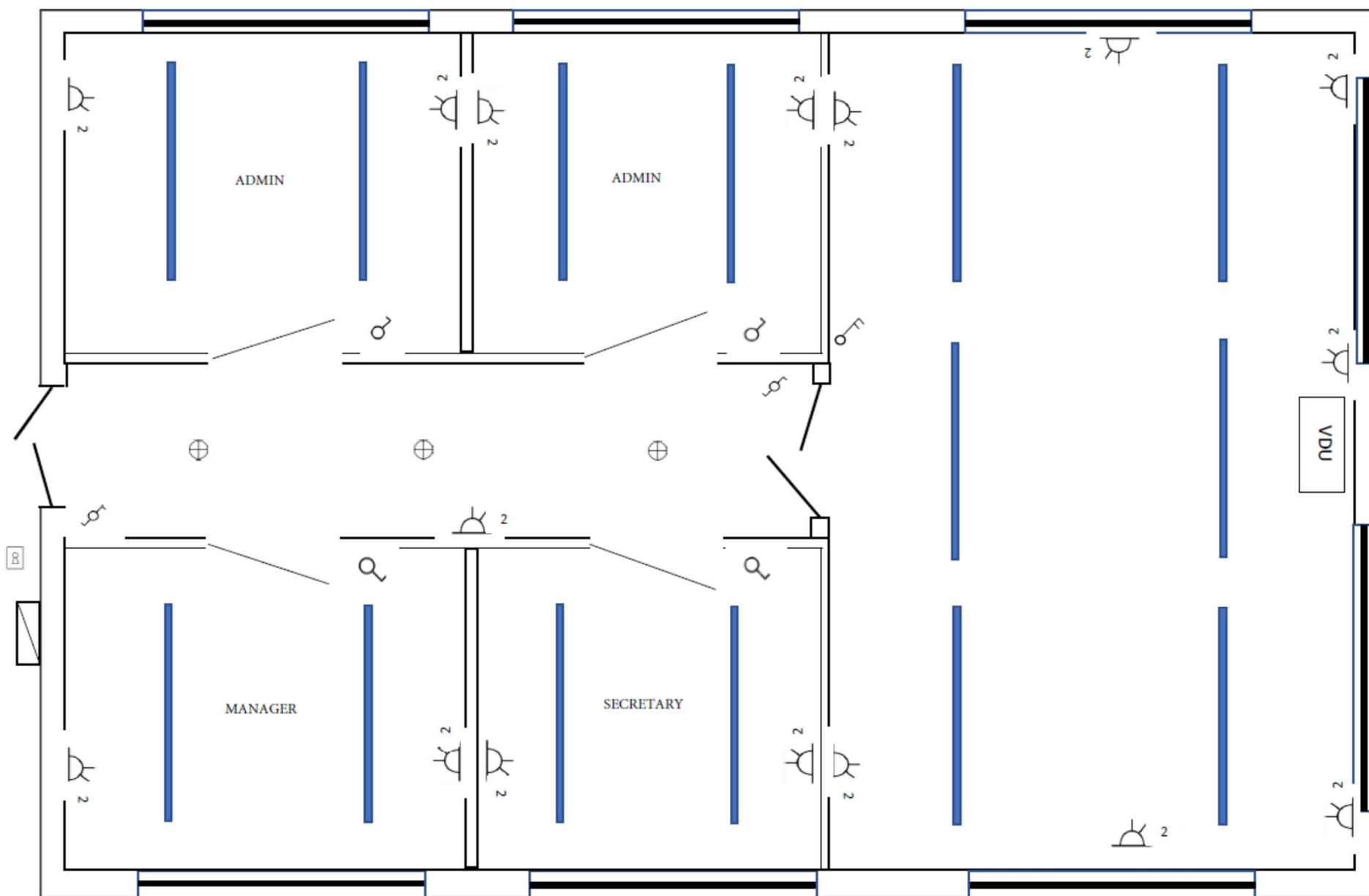
2 – GANG SWITCH



VISUAL DISPLAY UNIT



FLUORESCENT LIGHT FITTING



Commercial Office Installation

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

NOTE: The guidance offered below is linked to the five generic assessment criteria overleaf.

1. Engagement with Literature Skills

Your work must be informed and supported by scholarly material that is *relevant* to and *focused* on the task(s) set. You should provide evidence that you have accessed an appropriate *range* of sources, which may be academic, governmental and industrial; these sources may include academic journal articles, textbooks, current news articles, organisational documents, and websites. You should consider the *credibility* of your sources; academic journals are normally highly credible sources while websites require careful consideration/selection and should be used sparingly. Any sources you use should be current and up-to-date, mostly published within the last five years or so, though seminal/important works in the field may be older. You must provide *evidence* of your research/own reading throughout your work, using a suitable referencing system, including in-text citations in the main body of your work and a reference list at the end of your work.

Guidance specific to this assessment: You must provide evidence of individual research with respect to the area of study and provide relevant referencing.

2. Knowledge and Understanding Skills

At level 4, you should be able to demonstrate knowledge of the underlying concepts and principles associated with your area(s) of study. *Knowledge* relates to the facts, information and skills you have acquired through your learning. You demonstrate your *understanding* by interpreting the meaning of the facts and information (knowledge). This means that you need to select and include in your work the concepts, techniques, models, theories, etc. appropriate to the task(s) set. You should be able to explain the theories, concepts, etc. to show your understanding. Your mark/grade will also depend upon the *extent* to which you demonstrate your knowledge and understanding.

Guidance specific to this assessment: Your report and presentation should show you gained knowledge of the subject area.

3. Cognitive and Intellectual Skills

You should be able to present, evaluate and interpret qualitative and quantitative data, in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of your subject(s) of study. You should be able to evaluate the appropriateness of different approaches to solving problems related to your area(s) of study and/or work. Your work must contain evidence of logical, analytical thinking. For example, to examine and break information down into parts, make inferences, compile, compare and contrast information. This means not just describing what! But also justifying: Why? How? When? Who? Where? At what cost? You should provide justification for your arguments and judgements using evidence that you have reflected upon the ideas of others within the subject area and that you are able to make sound judgements and arguments using data and concepts. Where relevant, alternative solutions and recommendations may be proposed.

Guidance specific to this assessment: Your report should show sound judgements and arguments related to the scenario and your responses to tasks.

4. Practical Skills

At level 4, you should be able to apply the basic underlying concepts and principles to evaluate and interpret these within the context of your area of study. You should be able to demonstrate how the subject-related concepts and ideas relate to real world situations and/or a particular context. How do they work in practice? You will deploy models, methods, techniques, and/or theories, in that context, to assess current situations, perhaps to formulate plans or solutions to solve problems, or to create artefacts. This is likely to involve, for instance, the use of real world artefacts, examples and cases, the application of a model within an organisation and/or benchmarking one theory or organisation against others based on stated criteria.

Guidance specific to this assessment: Your report and presentation of practical work should indicate a level of research with respect to the application and deployment of the equipment, materials or processes that form the basis of the area of study.

5. Transferable Skills for Life and Professional Practice

Your work must provide evidence of the qualities and transferable skills necessary for employment requiring the exercise of some personal responsibility. This includes demonstrating: that you can communicate the results of your study/work accurately and reliably, and with structured and coherent arguments; that you can initiate and complete tasks and procedures, whether individually and/or collaboratively; fluency of expression; clarity and effectiveness in presentation and organisation. Work should be coherent and well-structured in presentation and organisation.

Guidance specific to this assessment: Your work should be well organised and presented in a professional manner.

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
Good literacy skills across the assignment. Clear depth of knowledge and understanding	25	20
2. Knowledge and Understanding Skills		
A very good transfer of knowledge and skills across the assignment.	25	20
3. Cognitive and Intellectual Skills		
Clear and vident throughout the assignment.	20	18
4. Practical Application Skills		
Knowledge and skills transfer well to practical application.	20	15
5. Transferable Skills for Life and Professional Practice		
Skills transfer well to professional practice	10	8

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to 1 week late (40% Max)

Over 1 week late (0%)

81 %

GENERIC ASSESSMENT CRITERIA

Level 4

In accordance with the Framework for Higher Education Qualifications, at the end of Level 4 students will be expected to have demonstrated knowledge of the basic underlying concepts and principles of a subject, and an ability to evaluate and interpret these within the context of that area of study. They should be able to present, evaluate and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of their subject(s) of study. They will have learned how to evaluate different approaches to solving problems, and will be able to communicate the results of their study/work accurately and reliably, and with structured and coherent arguments. They will be able to undertake further training and develop new skills within a structured and managed environment and will have the qualities and transferable skills necessary for employment requiring the exercise of some personal responsibility.

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-84%	85-100%
Engagement with literature (including reading, referencing, academic conventions and academic honesty)	Little or no evidence of reading and/or reliance on inappropriate sources. Views and findings mostly unsupported and non-authoritative. Referencing conventions used incoherently	Poor engagement with essential reading. No evidence of wider reading. Reliance on inappropriate sources, and/or indiscriminate use of sources. Heavily reliant on information gained through class	Engagement with a limited range of mostly relevant and credible sources but with some reliance on information gained through class contact. Some omissions and minor errors.	Engagement with an appropriate range of literature, including sources retrieved independently. Some over-reliance on texts rather than other sources. Referencing may show minor inaccuracies	Engagement with a wide range of literature, including sources retrieved independently. Selection of relevant and credible sources. Generally sound referencing, with no/very few	Engagement with an extensive range of relevant and credible literature. Consistently accurate application of referencing.	Exceptional engagement with an extensive range of relevant and credible literature. High-level referencing skills consistently applied.

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-84%	85-100%
	or largely absent.	contact. Inconsistent and weak use of referencing.	Referencing conventions evident though not always applied accurately or consistently.	or inconsistencies.	inaccuracies or inconsistencies.		
Knowledge and understanding (Knowledge of the basic underlying concepts and principles of a subject.)	Major gaps in knowledge and understanding of the basic underlying concepts and principles of the subject matter. Inclusion of irrelevant material. Substantial inaccuracies.	Gaps in knowledge of the basic underlying concepts and principles, with flawed or superficial understanding. Some significant inaccuracies and/or irrelevant material.	Limited knowledge and understanding of the basic underlying concepts and principles within the subject area. Some elements may be missing.	Knowledge of the basic underlying concepts and principles is accurate with a good understanding of the field of study but lacks depth and/or breadth.	Competent knowledge of the basic underlying concepts and principles. Exhibits very good understanding.	Excellent knowledge and understanding of the basic underlying concepts and principles of the subject.	Exceptional, detailed knowledge and understanding of the basic underlying concepts and principles
Cognitive and intellectual skills (Evaluate underlying concepts and principles of a subject and interpret qualitative and	Wholly or almost wholly descriptive work. Little or no evaluation of the underlying concepts and principles.	Largely descriptive work, with superficial evaluation of the underlying concepts and principles. Weak	Limited attempt at evaluation of the underlying concepts and principles, tending towards description.	Good evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative	Sound evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative	Excellent evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative	Exceptional evaluation of the underlying concepts and principles based evidence. Outstanding interpretation

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-84%	85-100%
quantitative data in order to develop lines of argument and make sound judgements.)	Failure to develop arguments, leading to illogical or invalid judgements. Minimal or no use of evidence to back up views.	interpretation of data, flawed development of arguments and judgements. Information accepted uncritically, uses generalised statements made with scant evidence and unsubstantiated opinions. Ideas sometimes illogical and contradictory.	Can interpret qualitative and quantitative data but with some errors. Some evidence to support emerging arguments and judgements but these may be underdeveloped or with a little inconsistency / mis-interpretation.	data, with minor errors. An emerging ability to use evidence to support the argument. Mostly valid arguments and logical judgements.	data accurately. Ability to devise arguments using evidence to make mostly appropriate and valid judgements.	data accurately and with some insight. Excellent ability to devise arguments using evidence and make appropriate and valid judgements.	of qualitative and quantitative data. Exceptional ability to devise arguments using evidence and make wholly appropriate and valid judgements.
Practical skills (Different approaches to solving problems in particular contexts.)	Limited or no use of taught, basic methods, materials, tools and/or techniques. Little or no appreciation of the context	Rudimentary application of taught, basic methods, materials, tools and/or techniques but without consideration and competence.	An adequate awareness and mostly appropriate application of basic methods, materials, tools and/or techniques.	A good and appropriate application of basic methods, materials, tools and/or techniques. Clear appreciation of the context	A very good application of a range of basic methods, materials, tools and/or techniques. Very good consideration of the context	An advanced application of a range of taught, basic methods, materials, tools and/or techniques. The context of the application is	Exceptional levels of application and deployment skills in particular practical contexts. Outstanding identification

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-84%	85-100%
	of the application. Very weak evidence of different approaches to problem-solving in particular contexts.	Flawed appreciation of the context of the application. Weak evidence of different approaches to problem-solving in particular contexts.	Basic appreciation of the context of the application. Can identify problems in particular contexts and propose basic alternative approaches or solutions though there may be errors.	of the application. Good evidence of different approaches to problem-solving in particular contexts and proposes mostly appropriate solutions.	of the application. Very good evidence of different approaches to problem-solving in particular contexts and proposes appropriate solutions.	well considered, and insightful. Excellent evidence of different approaches to problem-solving in particular contexts and proposes appropriate solutions.	of problems in particular contexts and formulation of wholly appropriate, thoughtful solutions / different approaches.
Transferable skills for life and professional practice (Communicate the results of their study/work accurately and reliably, and with structured and coherent arguments; the qualities needed for employment requiring the exercise of some personal responsibility within a structured	Work is poorly structured, disorganised, inaccurate and/or confusingly expressed. Very weak use of language and/or very inappropriate style. Failure to work effectively individual or	Work is poorly presented in a disjointed manner. It is loosely, and at times incoherently, structured, with information and ideas often poorly expressed. Weak use of language and/or	Mostly ordered presentation and structure in which relevant ideas / concepts are reasonably expressed. Work may lack coherence and/or accuracy in places. Can work as part of a group,	Mostly coherent, organised and accurate work, in a suitable structure and is for the most part clearly expressed. Can work effectively independently and/or as part of a team, with clear contribution to	Work is accurate, coherent, fluent, well-structured and organised. Can work effectively independently and/or as part of a team, with very good contribution to group activities.	Work is coherent, very fluent and is presented professionally . Can work effectively independently and/or as part of a team, with an excellent contribution to group activities. Demonstrates	Work is accurate, exceptionally coherent, very fluent and presented well. Can work effectively independently and/or as part of a team, with an exceptional contribution to group

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-84%	85-100%
and managed environment.)	as part of a group. Little or no evidence of the skills for employment requiring the exercise of some personal responsibility.	inappropriate style. Flawed approach to individual or group work, meeting only partial obligations to others. Limited evidence of the skills for employment requiring the exercise of some personal responsibility.	meeting most obligations to others but perhaps with limited involvement in group activities. Demonstrates the basic skills for employment requiring the exercise of some personal responsibility, with some areas of minor weakness.	group activities. Demonstrates the skills for employment requiring the exercise of some personal responsibility, with some areas of strength and some of minor weakness.	Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with just occasional minor weakness.	excellent skills for employment requiring the exercise of some personal responsibility with an appetite for further development.	activities. Demonstrates exceptional skills for employment requiring the exercise of some personal responsibility with an appetite for further development.