

**SULIT**



**KEMENTERIAN PENDIDIKAN TINGGI  
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI**

**BAHAGIAN PEPERIKSAAN DAN PENILAIAN  
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI  
KEMENTERIAN PENDIDIKAN TINGGI**

**JABATAN KEJURUTERAAN AWAM**

**PEPERIKSAAN AKHIR**

**SESI I : 2024/2025**

**DCB20042: BUILDING ELECTRICAL SERVICES**

**TARIKH : 25 NOVEMBER 2024  
MASA : 8.30PG – 10.30PG (2 JAM)**

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Kertas ini mengandungi **TIGA BELAS (13)** halaman bercetak.  
Bahagian A: Subjektif (2 soalan)  
Bahagian B: Subjektif (4 soalan)  
Dokumen sokongan yang disertakan : Appendix

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**JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN**

(CLO yang tertera hanya sebagai rujukan)

**SULIT**

**SECTION A: 50 MARKS****BAHAGIAN A: 50 MARKAH****INSTRUCTION:**

This section consists of **TWO (2)** subjective questions. Answer **ALL** questions.

**ARAHAN:**

Bahagian ini mengandungi **DUA (2)** soalan subjektif. Jawab **SEMUA** soalan.

**QUESTION 1****SOALAN 1**

- CLO2 (a) A miniature circuit breaker (MCB) is connected to each unit (nos) of 100W fluorescent tube lamp as shown in Figure A1(a). If 230V is supplied to a distribution board (DB), estimate the appropriate rate of MCB for the lighting circuit.

*Pemutus litar kenit (MCB) disambungkan kepada setiap unit (nos) 100W lampu tiub kalimantang seperti ditunjukkan dalam Rajah A1(a). Jika 230V dibekalkan ke papan agihan (DB), anggarkan kadar MCB yang sesuai untuk litar pencahayaan tersebut.*

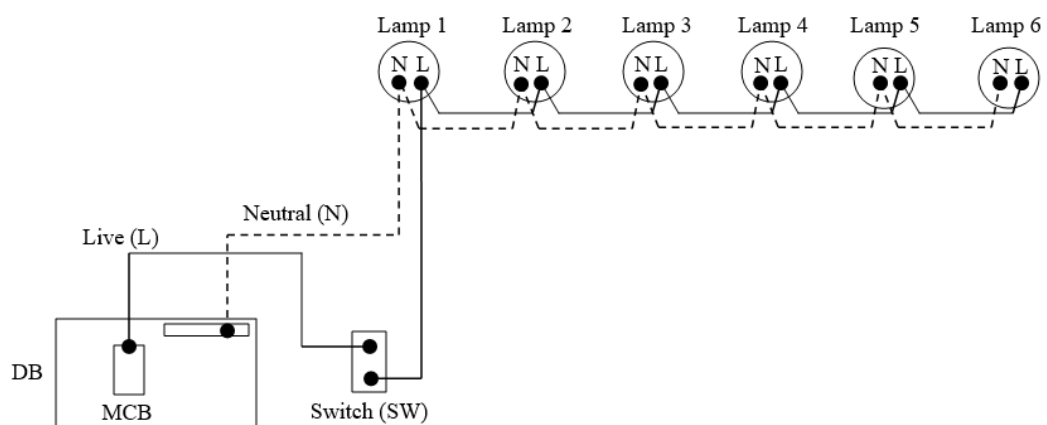


Figure A1(a) / Rajah A1(a)

[4 marks]

[4 markah]

- CLO2 (b) Two nos of instantaneous type water heater protected by MCB will be installed in Mr. Ali's house. The first water heater has wattage of 3.6kW and the second water heater has wattage of 4.2kW. His house is supplied by a 230V single phase power supply. As an electrical wireman, determine the appropriate MCB rating for both water heaters with the aid of Appendix 2 (Fuse rate for MCB).

*Dua buah pemanas air jenis segera yang dilindungi oleh pemutus litar (MCB) akan dipasang di rumah Encik Ali. Pemanas air pertama mempunyai watt sebanyak 3.6kW dan pemanas air kedua mempunyai watt sebanyak 4.2kW. Rumahnya dibekalkan dengan bekalan kuasa fasa tunggal 230V. Sebagai seorang pendawai elektrik, tentukan kadar MCB yang sesuai bagi kedua-dua pemanas air tersebut dengan berbantuan Lampiran 2 (kadar fuis untuk MCB).*

[9 marks]

[9 markah]

- CLO2 (c) PVC insulated core cable will be used in the enclosed conduit wiring for the installation of a 2.5hp (horsepower) split unit air conditioner in a residential house. This unit is supplied with 230V through a 35 meter long conduit pipe. As a competent wireman, with the aid of Table 4D1A and Table 4D1B in Appendix 3a and Appendix 3b, calculate the:

i. appropriate cable size.

[10 marks]

ii. voltage drop if 4mm<sup>2</sup> PVC insulated core cable is used.

[2 marks]

*Kabel teras bertebat PVC akan digunakan dalam pendawaian konduit tertutup untuk pemasangan pendingin hawa unit split 2.5hp (kuasa kuda) di sebuah rumah kediaman. Unit ini dibekalkan dengan 230V melalui paip konduit berukuran 35 meter panjang. Sebagai seorang pendawai yang bertauliah, dengan bantuan Jadual 4D1A dan Jadual 4D1B dalam Lampiran 3a dan Lampiran 3b, kirakan:*

i. saiz kabel yang sesuai.

[10 markah]

ii. penurunan voltan jika kabel teras berpenebat PVC 4mm<sup>2</sup> digunakan.

[2 markah]

**QUESTION 2****SOALAN 2**

- CLO2 (a) By referring to Appendix 1 (connected load), identify the estimated load for the following items in Table A2(a) according to JKR Electrical Engineering Branch Technique Guideline Edition 4.

*Dengan merujuk kepada Lampiran 1 (beban tersambung), kenalpasti anggaran beban bagi item berikut berdasarkan Panduan Teknik JKR Cawangan Kejuruteraan Elektrik Edisi 4.*

Table A2(a)/ *Jadual A2(a)*

| Electrical appliances/<br><i>Perkakasan elektrik</i>   | Nos |
|--------------------------------------------------------|-----|
| 36W fluorescent lamps / <i>lampu pendarflor</i>        | 3   |
| 13A 3P switch socket outlet / <i>soket alur keluar</i> | 4   |
| 3kW water heater / <i>pemanas air</i>                  | 1   |
| 2HP air conditioner / <i>penyaman udara</i>            | 1   |

[4 marks]

[4 markah]

- CLO2 (b) Based on Table A2(a) above, the loads with 230V single phase power supply will be installed in a dining hall. Assume that the diversity factor for lamp, 13A switch socket, and water heater are 0.8, 0.4, and 1 respectively.

Calculate the total connected load (TCL) and maximum demand (MD) for the loads by referring to JKR Electrical Engineering Branch Technique Guideline Edition 4.

*Berdasarkan Jadual A2(a) di atas, beban dengan bekalan kuasa tunggal 230V akan dipasang dalam dewan makan. Andaikan bahawa faktor kepelbagaian untuk lampu, soket suis 13A, dan pemanas air masing-masing adalah 0.8, 0.4, dan 1.*

*Kirakan jumlah beban bersambung (TCL) dan permintaan maksimum (MD) untuk beban dengan merujuk Garis Panduan Teknik Cawangan Kejuruteraan Elektrik JKR Edisi 4.*

[9 marks]

[9 markah]

CLO2

- (c) Mr. Ali, a competent wireman is going to install the following electrical fittings and appliances at two locations as listed in Table A2(c). Both locations are supplied with 230V single phase power supply. By referring to JKR Electrical Engineering Branch Technique Guideline Edition 4 and the Diversity Factor (DF) provided in Appendix 4, calculate the Total Connected Load (TCL) and the Maximum Demand (MD) for both locations (Location 1 and Location 2).

*Encik Ali, seorang pendawai yang bertaualiah akan memasang kelengkapan dan perkakas elektrik berikut di dua lokasi seperti yang disenaraikan dalam Jadual A2(c). Kedua-dua lokasi dibekalkan dengan bekalan kuasa fasa tunggal 230V. Dengan merujuk Garis Panduan Teknik Cawangan Kejuruteraan Elektrik JKR Edisi 4 dan Faktor Kepelbagaian (DF) yang disediakan dalam Lampiran 4, kirakan Jumlah Beban Bersambung (TCL) dan Permintaan Maksimum (MD) untuk kedua-dua lokasi (Lokasi 1 dan Lokasi 2).*

Table A2(c)/ Jadual A2(c)

| Electrical appliances/<br>Perkakasan elektrik               | Nos | Locations / Lokasi                                                |                          |
|-------------------------------------------------------------|-----|-------------------------------------------------------------------|--------------------------|
| 1200mm ceiling fan /<br>1200mm kipas siling                 | 4   | Location 1/<br>Lokasi 1:                                          | Location 2/<br>Lokasi 2: |
| 13A 3P switch socket<br>outlet /<br>13A 3P suis alur keluar | 6   | Non-essential<br>health center/<br>Pusat kesihatan<br>bukan-utama | Quarters/ Kuarters       |

[12 marks]

[12 markah]

**SECTION B : 50 MARKS****BAHAGIAN B : 50 MARKAH****INSTRUCTION:**

This section consists of **FOUR (4)** subjective questions. Answer **TWO (2)** questions only.

**ARAHAN:**

*Bahagian ini mengandungi **EMPAT (4)** soalan subjektif. Jawab **DUA (2)** soalan sahaja.*

**QUESTION 1****SOALAN 1**

- CLO1 (a) List any **FOUR (4)** methods of electrical power distribution system.

*Senaraikan mana-mana **EMPAT (4)** kaedah sistem pengagihan kuasa elektrik.*

[4 marks]

[4 markah]

- CLO1 (b) A regulatory instrument namely the Grid Code and Distribution Code, launched and published by Energy Commission Malaysia on 21<sup>st</sup> December 2010, is used to coordinate various electricity supply activities of the electricity producer, operator, distributor, and the consumer. Describe the following electric power supply systems in context of Malaysia.

- i. Generation
- ii. Transmission
- iii. Three-phase supply

*Instrumen kawal selia iaitu Kod Grid dan Kod Pengagihan yang telah dilancarkan dan diterbitkan oleh Suruhanjaya Tenaga Malaysia pada 21 Disember 2010 digunakan untuk menyelaraskan pelbagai aktiviti bekalan elektrik bagi pengeluar, pengendali, pengedar dan pengguna elektrik. Jelaskan sistem bekalan kuasa elektrik berikut dalam konteks Malaysia.*

- i. *Penjanaan*
- ii. *Penghantaran*
- iii. *Bekalan tiga-fasa*

[9 marks]

[9 markah]

CLO1

- (c) Mr. Wong rented a house that has a kitchen and a living room as specified in Table B2(c)(i). By referring to circuit type provided in Table B2(c)(ii), illustrate the suitable circuit diagram to control 13A socket outlets based on specified location in Table B2(c)(i).

*Encik Wong menyewa sebuah rumah yang mempunyai dapur dan ruang tamu seperti diperincikan dalam Jadual B2(c)(i). Dengan merujuk kepada jenis litar yang disediakan dalam Jadual B2(c)(ii), gambarkan gambarajah litar yang sesuai untuk mengawal alur keluar soket 13A berdasarkan lokasi yang ditentukan dalam Jadual B2(c)(i).*

Table B2(c)(i) / Jadual B2(c)(i)

| Location/ Lokasi        | Room Area (m <sup>2</sup> )/ Luas bilik | Number of sockets to be installed (nos)/ Bilangan soket yang dipasang (nos) |
|-------------------------|-----------------------------------------|-----------------------------------------------------------------------------|
| Kitchen/ Dapur          | 17.5                                    | 2                                                                           |
| Living room/ Ruang tamu | 63                                      | 6                                                                           |

Table B2(c)(ii) / Jadual B2(c)(ii)

| Circuit Type/ Jenis litar | Over Current Protection Rating (Fuse or MCB)/ Kadar Pelindung Arus Lebih (MCB) | Minimum Size of Copper Conductor in PVC or Rubber Insulation (mm <sup>2</sup> )/ Saiz minimum pengalir kurprum dalam PVC atau Penebat Getah (mm <sup>2</sup> ) | Maximum Floor Area (m <sup>2</sup> )/ Luas maksimum Lantai (m <sup>2</sup> ) |
|---------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Ring/ Gelang              | 30 or 32                                                                       | 2.5                                                                                                                                                            | 100                                                                          |
| Radial/ Jejari            | 30 or 32                                                                       | 4.0                                                                                                                                                            | 50                                                                           |
| Radial/ Jejari            | 20                                                                             | 2.5                                                                                                                                                            | 20                                                                           |

[12 marks]

[12 markah]

**QUESTION 2****SOALAN 2**

- CLO1 (a) Identify any **FOUR (4)** factors in selecting the surface type wiring system.  
*Kenalpasti mana-mana **EMPAT (4)** faktor bagi pemilihan sistem pendawaian jenis permukaan.*  

[4 marks]  
[4 markah]
- CLO1 (b) An office building is undergoing a renovation project. The renovation includes adding new electrical wiring to accommodate additional workstations, computers, and other electronic equipment. The office space is designed with a modern and clean aesthetic, and the stakeholders want to avoid exposed wires running across the walls, ceilings, or floors. Explain the appropriate types of wiring used and reasons for selecting that wiring type.  
*Sebuah bangunan pejabat sedang menjalani projek pengubahsuaian. Pengubahsuaian tersebut termasuk menambah pendawaian elektrik baharu untuk menampung stesen kerja tambahan, komputer dan peralatan elektronik lain. Ruang pejabat direka bentuk dengan estetik moden dan bersih, dan pihak berkepentingan ingin mengelakkan wayar terdedah yang melintasi dinding, siling atau lantai. Terangkan jenis pendawaian yang sesuai digunakan dan sebab untuk memilih jenis pendawaian tersebut.*  

[9 marks]  
[9 markah]
- CLO1 (c) Figure B2(c) shows the single phase electrical wiring schematic diagram connected to the final circuits. As an electrical contractor, explain:  

i. any **TWO (2)** of the electrical accessories used in the wiring system.  

[4 marks]

ii. IEEE regulations associated with the accessories in Circuit 1 and Circuit 4 respectively.  

[8 marks]

Rajah B2(c) menunjukkan rajah skema pendawaian elektrik satu fasa yang bersambung dengan litar akhir. Sebagai seorang kontraktor elektrik, terangkan:

i. mana-mana **DUA (2)** aksesori elektrik yang digunakan dalam sistem pendawaian.

[4 markah]

ii. Peraturan IEEE berkaitan dengan aksesori yang digunakan masing-masing dalam Litar 1 dan Litar 4.

[8 markah]

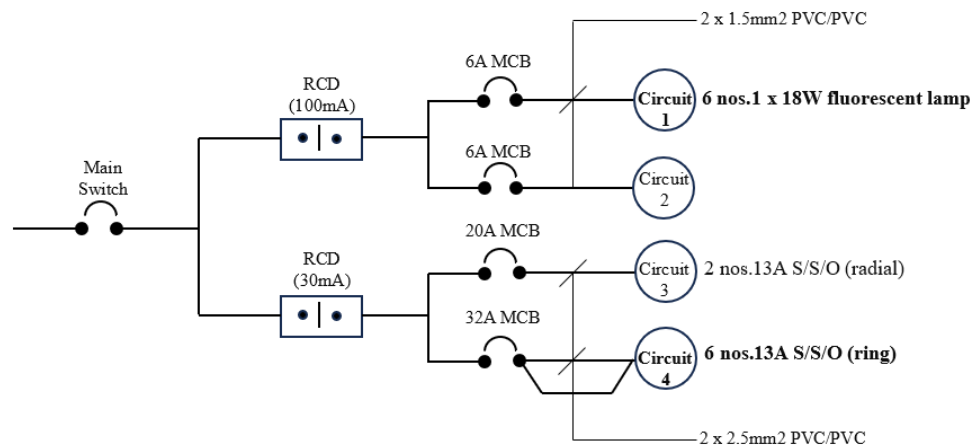


Figure B2(c) / Rajah B2(c)

**QUESTION 3****SOALAN 3**

- CLO1 (a) Earthing is a fundamental aspect in electrical installations. It serves several crucial purposes and its importance lies in enhancing the safety and reliability of electrical systems. Identify the importance of earthing in electrical installations.

*Pembumian adalah aspek asas dalam pemasangan elektrik. Ia mempunyai beberapa tujuan penting dan kepentingannya terletak pada meningkatkan keselamatan dan kebolehpercayaan sistem elektrik. Kenalpasti kepentingan pembumian dalam pemasangan elektrik.*

[4 marks]

[4 markah]

- CLO1 (b) When a component or part of an electrical system is earthed, it means that it is intentionally connected to the earth through a low-resistance conductive path. In some electrical systems, certain components may be intentionally left ungrounded. This is often the case in isolated systems or systems where grounding is not necessary. Describe the parts required and not required to be earthed.

*Apabila komponen atau sebahagian daripada sistem elektrik dibumikan, ini bermakna ia sengaja disambungkan ke bumi melalui laluan konduktif rintangan rendah. Dalam sesetengah sistem elektrik, komponen tertentu mungkin sengaja dibiarkan tidak dibumikan. Ini selalunya berlaku dalam sistem atau sistem terpencil di mana pembumian tidak diperlukan. Jelaskan bahagian yang perlu dan tidak perlu untuk dibumikan.*

[9 marks]

[9 markah]

CLO1

- (c) Reducing earthing resistance is important to ensure an effective and safe electrical grounding system. It is important that the choice of method depends on factors such as soil resistivity, site conditions, and specific requirements. Explain the common methods used to achieve lower earthing resistance.

*Mengurangkan rintangan pbumian adalah penting untuk memastikan sistem pbumian elektrik adalah berkesan dan selamat. Adalah penting bahawa pilihan kaedah bergantung kepada faktor-faktor seperti kerintangan tanah, keadaan tapak, dan keperluan khusus. Terangkan kaedah yang biasa digunakan untuk mencapai rintangan pbumian yang lebih rendah.*

[12 marks]

[12 markah]

**QUESTION 4****SOALAN 4**

- CLO1 (a) On completion of a wiring installation, a number of tests on the installation have to be conducted to ascertain that the wiring circuits and connected appliances are safe for use. Prior to carrying out the tests, an inspection has to be done. Identify **FOUR (4)** purpose of conducting the test.

*Dalam menyiapkan pemasangan pendawaian, beberapa ujian ke atas pemasangan perlu dijalankan untuk memastikan bahawa litar pendawaian dan peralatan yang disambungkan selamat untuk digunakan. Sebelum menjalankan ujian, pemeriksaan perlu dilakukan. Kenal pasti **EMPAT (4)** tujuan menjalankan ujian tersebut.*

[4 marks]

[4 markah]

- CLO1 (b) The switch socket outlet in Mr. Ali's room appears to be non-functional. When he plugs in a device, it does not receive power, and he suspects that there might be a wiring issue. As an electrical technician, explain the suitable testing to be conducted for finding the cause of non-functional switch socket outlet.

*Soket alur keluar elektrik di bilik Encik Ali didapati tidak berfungsi. Apabila dia memasang peranti, peranti itu tidak menerima kuasa, dan dia mengesyaki mungkin terdapat masalah pendawaian. Sebagai juruteknik elektrik, terangkan ujian yang sesuai dijalankan untuk mencari punca soket alur keluar elektrik tidak berfungsi.*

[9 marks]

[9 markah]

CLO1

- (c) A homeowner is experiencing issues with a toaster in his kitchen. The toaster seems to be malfunctioning as it is not heating up properly. The homeowner suspects that there might be an issue with the electrical supply to the appliance and decides to investigate with the help of a competent electrician. As a competent electrician, explain the appropriate testing to be carried out to solve this issue (with the aid of a suitable diagram).

*Pemilik rumah menghadapi masalah dengan pembakar roti di dapurnya. Pembakar roti kelihatan tidak berfungsi, kerana ia tidak panas dengan betul. Pemilik rumah mengesyaki mungkin terdapat masalah dengan bekalan elektrik kepada perkakas itu dan memutuskan untuk menyiasat dengan bantuan seorang juruelektrik yang kompeten. Sebagai seorang juruelektrik yang kompeten, terangkan ujian yang sesuai dijalankan untuk menyelesaikan isu ini (dengan bantuan gambarajah yang sesuai).*

[12 marks]

[12 markah]

**SOALAN TAMAT**

APPENDIX 1/ *LAMPIRAN 1*

## Appendix 1: TCL Guide (updated: 15.5.2006)

| NO | DESCRIPTION                   | ESTIMATED LOAD    |
|----|-------------------------------|-------------------|
| 1  | 18W Fluorescent               | 24W               |
| 2  | 36W Fluorescent               | 42W               |
| 3  | 60W Tungsten                  | 60W               |
| 4  | 100W Tungsten                 | 100W              |
| 5  | 1 x 8W(F) EL                  | 10W               |
| 6  | 2 X 8W(F) LAMPU 'K' SIGN      | 20W               |
| 7  | 9W PLC                        | 15W               |
| 8  | 11W PLC                       | 17W               |
| 9  | 13W PLC                       | 19W               |
| 10 | 18W PLC                       | 24W               |
| 11 | 9W PLCE                       | 10W               |
| 12 | 11W PLCE                      | 12W               |
| 13 | 13W PLCE                      | 14W               |
| 14 | 18W PLCE                      | 20W               |
| 15 | 50W Halogen Bulb              | 50W               |
| 16 | 70W Metal Halide/SON          | 80W               |
| 17 | 150W Metal Halide/SON         | 170W              |
| 18 | 250W Metal Halide/SON         | 280W              |
| 19 | 400W Metal Halide/SON         | 440W              |
| 20 | Obstruction Light             | 100W              |
| 21 | Electric Bell                 | Ignore            |
| 22 | 2 x 8W(F) Insect Killer       | 20W               |
| 23 | 1500mm Ceiling Fan            | 80W               |
| 24 | 1200 Ceiling Fan              | 60W               |
| 25 | 400mm Wall Fan                | 60W               |
| 26 | 500 Wall Fan                  | 80W               |
| 27 | 400mm Automatic Fan           | 80W               |
| 28 | 200mm Exhaust Fan             | 15W               |
| 29 | 250mm Exhaust Fan             | 25W               |
| 30 | 300mm Exhaust Fan             | 40W               |
| 31 | 13A 3P Switched Socket Outlet | 250W              |
| 32 | 15A Switched Socket Outlet    | 500W              |
| 33 | 15A SPN Isolator              | Motor H.P. rating |
| 34 | 20A SPN Isolator              | Motor H.P. rating |
| 35 | 30A SPN Isolator              | Motor H.P. rating |
| 36 | 15A TPN Isolator              | Motor H.P. rating |
| 37 | 20A TPN Isolator              | Motor H.P. rating |
| 38 | 30A TPN Isolator              | Motor H.P. rating |
| 39 | 45A TPN Isolator              | Motor H.P. rating |
| 40 | 60A TPN Isolator              | Motor H.P. rating |
| 41 | 1 HP Air-Cond                 | 746W              |
| 42 | 1.5 HP Air-Cond               | 1119W             |
| 43 | 2 HP Air-Cond                 | 1492W             |
| 44 | 2.5 HP Air-Cond               | 1865W             |
| 45 | 3 HP Air-Cond                 | 2238W             |
| 46 | Water Heater                  | 3kW               |
| 47 | Cooker                        | 7.5kW             |
| 48 | Booster Pump                  | Motor H.P. rating |
| 49 | Fire Fighting Pump            | Motor H.P. rating |
| 50 | Fire Fighting Panel           | 250W              |
| 51 | CO2 Point                     | 500W              |
| 52 | SATS System                   | 500W              |
| 53 | HI KLEEN System               | Motor H.P. rating |

APPENDIX 2/ *LAMPIRAN 2***Fuse rate for MCCB, MCB and RCCB**

| Molded Case Circuit Breaker ( <b>MCCB</b> ) |                                                       |
|---------------------------------------------|-------------------------------------------------------|
| Voltage rating                              | : 230V/400V                                           |
| Current rating                              | : 16A, 20A, 30A, 40A, 50A, 60A, 80A, 100A until 2000A |
| Double Pole/ TPN/4 Pole                     |                                                       |

| Miniature Circuit Breaker ( <b>MCB</b> ) |                                                      |
|------------------------------------------|------------------------------------------------------|
| Voltage rating                           | : 230V/400V                                          |
| Current rating                           | : 2A, 4A, 6A, 10A, 16A, 20A, 25A, 32A, 40A, 50A, 63A |
| Single Pole/Double Pole/ 3 Pole/4 Pole   |                                                      |

| Residual Current Circuit Breaker ( <b>RCCB</b> ) |                                   |
|--------------------------------------------------|-----------------------------------|
| Voltage rating                                   | : 230V/400V                       |
| Current rating                                   | : 16A, 25A, 40A, 63A, 80A         |
| Sensitivity ( $I_{\Delta n}$ )                   | : 10mA, 30mA, 100mA, 300mA, 500mA |
| Single Pole/Double Pole/ 3 Pole/4 Pole           |                                   |

**TABLE 4D1A**

Single-core pvc-insulated cables, non-armoured, with or without sheath  
(COPPER CONDUCTORS)

BS 6004

BS 6231

Ambient temperature : 30 °C

BS 6346

Conductor operating temperature : 70 °C

CURRENT-CARRYING CAPACITY (amperes):

| Conductor cross-sectional area | Reference Method 4<br>(Enclosed in conduit in thermally insulating wall etc.) |                                | Reference Method 3<br>(enclosed in conduit on a wall or in trunking etc.) |                                | Reference Method 1<br>(clipped direct)              |                                                             | Reference Method 11<br>(on a perforated cable tray horizontal or vertical) |                                                             | Reference Method 12 (free air) |                      |         |
|--------------------------------|-------------------------------------------------------------------------------|--------------------------------|---------------------------------------------------------------------------|--------------------------------|-----------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------|--------------------------------|----------------------|---------|
|                                | 2 cables, single-phase a.c or d.c                                             | 3 or 4 cables, three-phase a.c | 2 cables, single-phase a.c or d.c                                         | 3 or 4 cables, three-phase a.c | 2 cables, single-phase a.c or d.c flat and touching | 3 or 4 cables, three-phase a.c flat and touching or trefoil | 2 cables, single-phase a.c or d.c flat and touching                        | 3 or 4 cables, three-phase a.c flat and touching or trefoil | Horizontal flat spaced         | Vertical flat spaced | Trefoil |
| 1                              | 2                                                                             | 3                              | 4                                                                         | 5                              | 6                                                   | 7                                                           | 8                                                                          | 9                                                           | 10                             | 11                   | 12      |
| (mm <sup>2</sup> )             | (A)                                                                           | (A)                            | (A)                                                                       | (A)                            | (A)                                                 | (A)                                                         | (A)                                                                        | (A)                                                         | (A)                            | (A)                  | (A)     |
| 1                              | 11                                                                            | 10.5                           | 13.5                                                                      | 12                             | 15.5                                                | 14                                                          | -                                                                          | -                                                           | -                              | -                    | -       |
| 1.5                            | 14.5                                                                          | 13.5                           | 17.5                                                                      | 15.5                           | 20                                                  | 18                                                          | -                                                                          | -                                                           | -                              | -                    | -       |
| 2.5                            | 19.5                                                                          | 18                             | 24                                                                        | 21                             | 27                                                  | 25                                                          | -                                                                          | -                                                           | -                              | -                    | -       |
| 4                              | 26                                                                            | 24                             | 32                                                                        | 28                             | 37                                                  | 33                                                          | -                                                                          | -                                                           | -                              | -                    | -       |
| 6                              | 34                                                                            | 31                             | 41                                                                        | 36                             | 47                                                  | 43                                                          | -                                                                          | -                                                           | -                              | -                    | -       |
| 10                             | 46                                                                            | 42                             | 57                                                                        | 50                             | 65                                                  | 59                                                          | -                                                                          | -                                                           | -                              | -                    | -       |
| 16                             | 61                                                                            | 56                             | 76                                                                        | 68                             | 87                                                  | 79                                                          | -                                                                          | -                                                           | -                              | -                    | -       |
| 25                             | 80                                                                            | 73                             | 101                                                                       | 89                             | 114                                                 | 104                                                         | 126                                                                        | 112                                                         | 146                            | 130                  | 110     |
| 35                             | 99                                                                            | 89                             | 125                                                                       | 110                            | 141                                                 | 129                                                         | 156                                                                        | 141                                                         | 181                            | 162                  | 137     |
| 50                             | 119                                                                           | 108                            | 151                                                                       | 134                            | 182                                                 | 167                                                         | 191                                                                        | 172                                                         | 219                            | 197                  | 167     |
| 70                             | 151                                                                           | 136                            | 192                                                                       | 171                            | 234                                                 | 214                                                         | 246                                                                        | 223                                                         | 281                            | 254                  | 216     |
| 95                             | 182                                                                           | 164                            | 232                                                                       | 207                            | 284                                                 | 261                                                         | 300                                                                        | 273                                                         | 341                            | 311                  | 264     |

TABLE 4D1B

VOLTAGE DROP (per ampere per metre):

Conductor operating temperature : 70°C

| Conductor cross-sectional area | 2 cables d.c | 2 cables, single-phase a.c                                        |      |      |                                                                |       |      |                               |      |      | 3 or 4 cables, three-phase a.c                                    |      |      |                                          |       |      |                                             |      |      |                               |      |      |
|--------------------------------|--------------|-------------------------------------------------------------------|------|------|----------------------------------------------------------------|-------|------|-------------------------------|------|------|-------------------------------------------------------------------|------|------|------------------------------------------|-------|------|---------------------------------------------|------|------|-------------------------------|------|------|
|                                |              | Reference Method 3 & 4 (Enclosed in conduit etc. in or on a wall) |      |      | Reference Method 1 & 11 (clipped direct or on trays, touching) |       |      | Reference Method 12 (spaced*) |      |      | Reference Method 3 & 4 (Enclosed in conduit etc. in or on a wall) |      |      | Reference Method 1, 11 & 12 (in trefoil) |       |      | Reference Method 1 & 11 (flat and touching) |      |      | Reference Method 12 (spaced*) |      |      |
| 1                              | 2            | 3                                                                 |      |      | 4                                                              |       |      | 5                             |      |      | 6                                                                 |      |      | 7                                        |       |      | 8                                           |      |      | 9                             |      |      |
| (mm <sup>2</sup> )             | (mV/A/m)     | (mV/A/m)                                                          |      |      | (mV/A/m)                                                       |       |      | (mV/A/m)                      |      |      | (mV/A/m)                                                          |      |      | (mV/A/m)                                 |       |      | (mV/A/m)                                    |      |      | (mV/A/m)                      |      |      |
| 1                              | 44           | 44                                                                |      |      | 44                                                             |       |      | 44                            |      |      | 38                                                                |      |      | 38                                       |       |      | 38                                          |      |      | 38                            |      |      |
| 1.5                            | 29           | 29                                                                |      |      | 29                                                             |       |      | 29                            |      |      | 25                                                                |      |      | 25                                       |       |      | 25                                          |      |      | 25                            |      |      |
| 2.5                            | 18           | 18                                                                |      |      | 18                                                             |       |      | 18                            |      |      | 15                                                                |      |      | 15                                       |       |      | 15                                          |      |      | 15                            |      |      |
| 4                              | 11           | 11                                                                |      |      | 11                                                             |       |      | 11                            |      |      | 9.5                                                               |      |      | 9.5                                      |       |      | 9.5                                         |      |      | 9.5                           |      |      |
| 6                              | 7.3          | 7.3                                                               |      |      | 7.3                                                            |       |      | 7.3                           |      |      | 6.4                                                               |      |      | 6.4                                      |       |      | 6.4                                         |      |      | 6.4                           |      |      |
| 10                             | 4.4          | 4.4                                                               |      |      | 4.4                                                            |       |      | 4.4                           |      |      | 3.8                                                               |      |      | 3.8                                      |       |      | 3.8                                         |      |      | 3.8                           |      |      |
| 16                             | 2.8          | 2.8                                                               |      |      | 2.8                                                            |       |      | 2.8                           |      |      | 2.4                                                               |      |      | 2.4                                      |       |      | 2.4                                         |      |      | 2.4                           |      |      |
|                                |              | r                                                                 | x    | z    | r                                                              | x     | z    | r                             | x    | z    | r                                                                 | x    | z    | r                                        | x     | z    | r                                           | x    | z    | r                             | x    | z    |
| 25                             | 1.75         | 1.80                                                              | 0.33 | 1.80 | 1.75                                                           | 0.20  | 1.75 | 1.75                          | 0.29 | 1.80 | 1.50                                                              | 0.29 | 1.55 | 1.50                                     | 0.175 | 1.50 | 1.50                                        | 0.25 | 1.55 | 1.50                          | 0.32 | 1.55 |
| 35                             | 1.25         | 1.30                                                              | 0.31 | 1.30 | 1.25                                                           | 0.195 | 1.25 | 1.25                          | 0.28 | 1.30 | 1.10                                                              | 0.27 | 1.10 | 1.10                                     | 0.170 | 1.10 | 1.10                                        | 0.24 | 1.10 | 1.10                          | 0.32 | 1.15 |
| 50                             | 0.93         | 0.95                                                              | 0.30 | 1.00 | 0.93                                                           | 0.190 | 0.95 | 0.93                          | 0.28 | 0.97 | 0.81                                                              | 0.26 | 0.85 | 0.80                                     | 0.165 | 0.82 | 0.80                                        | 0.24 | 0.84 | 0.80                          | 0.32 | 0.86 |
| 70                             | 0.63         | 0.65                                                              | 0.29 | 0.72 | 0.63                                                           | 0.185 | 0.66 | 0.63                          | 0.27 | 0.69 | 0.56                                                              | 0.25 | 0.61 | 0.55                                     | 0.160 | 0.57 | 0.55                                        | 0.24 | 0.60 | 0.55                          | 0.31 | 0.63 |
| 95                             | 0.46         | 0.49                                                              | 0.28 | 0.56 | 0.47                                                           | 0.180 | 0.50 | 0.47                          | 0.27 | 0.54 | 0.42                                                              | 0.24 | 0.48 | 0.41                                     | 0.155 | 0.43 | 0.41                                        | 0.23 | 0.47 | 0.40                          | 0.31 | 0.51 |

Note : \* Spacings larger than those specified in Method 12 (see Table 4A1) will result in larger voltage drop

APPENDIX 4/ *LAMPIRAN 4*

## Appendix 4: Diversity Factor (DF)

Updated: 21<sup>st</sup> March 2008

| Building         | School | Health    |               | Mosque | Hall | Hostel |           | Dining Hall/<br>Canteen | Office | Lab      |         | Quarters |
|------------------|--------|-----------|---------------|--------|------|--------|-----------|-------------------------|--------|----------|---------|----------|
|                  |        | Essential | Non-Essential |        |      | School | Executive |                         |        | Computer | Science |          |
| Lamp/Fan         | 0.8    | 0.8       | 0.9           | 0.9    | 0.8  | 0.8    | 0.8       | 0.8                     | 0.8    | 0.8      | 0.8     | 0.8      |
| 13A S/S/O        | 0.1    | 0.4       | 0.4           | 0.4    | 0.4  | 0.1    | 0.4       | 0.4                     | 0.4    | 0.6      | 0.6     | 0.5      |
| 15A S/S/O        | 1      | 1         | 1             | 1      | 1    | 1      | 1         | 1                       | 1      | 1        | 1       | 1        |
| AC Motor Pump    | 1      | 1         | 1             | 1      | 1    | -      | 1         | 1                       | 1      | 1        | 1       | 1        |
| Outdoor Lighting | 1      | 1         | 1             | 1      | -    | -      | -         | -                       | 1      | 1        | 1       | 1        |
| Water Heater     | -      | -         | -             | -      | -    | -      | 1         | 1                       | -      | -        | -       | 1        |
| Cooker Unit      | 1      | 1         | 1             | -      | -    | -      | -         | -                       | -      | -        | -       | -        |
| Isolator         | 1      | 1         | 1             | 1      | 1    | 1      | 1         | 1                       | 1      | -        | -       | -        |

Note: \* DF may be relook based on the day and night profile usage.