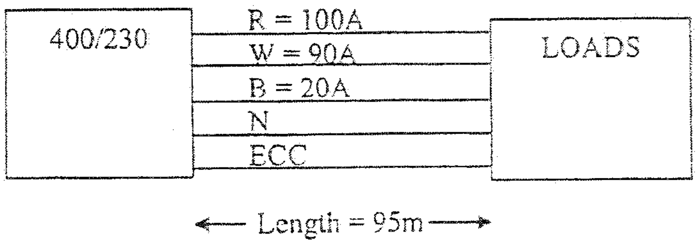
QUESTION 1
SANS 10142 PART 1 OF 2003

A 4 core armoured, PVC, ECC copper cable with a total length of 95 meters, must supply the following resistive loads if the supply is 400/230 volts.

- Red phase 100A
- White phase 90 A
- Blue phase 20 A
- Ignore volt drop after the main cable

Draw the circuit and then determine:

1.1	The minimum main cable size	(4)
1.2	The actual % phase to neutral volt drop on the blue phase if the cable in 1.1 is used.	(3)
1.3	The main protection tripping rating	(1)
1.4	The current unbalanced factor	(1)
1.5	The actual resistance of the ECC if it is the same size as one of the phase conductors	(1)



1. Calculate the total neutral unbalance first

$$N = \sqrt{R^2 + W^2 + B^2 - [RW + WB + RB]}$$

$$N = \sqrt{100^2 + 90^2 + 20^2 - [9000 + 1800 + 2000]}$$

$$N = \sqrt{18500 - 12800}$$

$$N = \sqrt{5700}$$

$$N = 75{,}498\,Amps$$

$$VD = \frac{I \times \rho L}{A}$$

$$A = \frac{I \times \rho L}{VD}$$

$$A = \frac{100 \times 0.0233 \times 95}{5.75}$$

$$A = 38.495\ mm^2$$

(1.1) **Thus use a 35mm² copper cable**

R Ø phase volt drop $= \frac{1.1}{1000} \times 95 \times \frac{100}{1.732}$
$= 6.033V$

VOLT DROP N $= \frac{1.1}{1000} \times 95 \times \frac{75.498}{1.732}$
$= 4.555V$

TOTAL VOLT DROP RED CIRCUIT
$= 6.033 + 4.555$
$= 10.588$ VOLT

Thus a 35mm² copper cable can be used.

(1.2) **Volt drop Blue Ø phase** $= \frac{20}{1.732} \times 95 \times \frac{1.1}{1000}$
$= 1.206V$

Volt drop neutral $= 75.498 \times \frac{1.1}{1000} \times \frac{95}{1.732}$
$= 4.555$ Volts

TOTAL VOLT DROP BLUE PHASE
$= 1.200 \times 4.555$
$= 5.761$

% VD $= \frac{5.761}{230} \times 100 = 2.504\ \%$

(1.3) 100 x 1.25% = 125A

(1.4) K $= \frac{IH - IL}{IH} \times 100\%$
$= \frac{100 - 20}{100} \times 100\%$
$= 80\%$

(1.5) 35mm² $= \frac{.63}{1000} \times 95$

QUESTION 2
SANS 10142 PART 1 OF 2003
(General circuit arrangements)

In a three-phase four-wire circuit that supplies only single phase loads of electrical equipment (that are connected between a phase conductor and the neutral conductor may supply any number of points if the circuit meets with FOUR main requirements regarding the protection of the circuit. Elaborate on all of them. [10]
Answers must be in point form.

√ a) the circuit is protected by

1) a multipole circuit-breaker, or

2) single-phase protective devices with a multipole switch-disconnector on the supply side,

√ b) throughout the circuit, the neutral conductor has the same nominal cross-sectional area as the associated phase conductors,

√ c) tee-joints are accessible and the main neutral conductor remains unbroken when tee-joints are removed, and

√ d) the total load is, as nearly as is practicable, balanced over the three phases.

Where it is required to separately control a part of an installation (such as fire services or emergency equipment), it shall be supplied by a separate dedicated circuit.

- All the conductors of any circuit shall originate at the same distribution board.

- A maximum of three conductors may be connected to any one terminal provided that the terminal has the correct rating.

- The neutral conductor shall not be connected direct to earth or to the earth continuity conductor on the load side of the point of control.

QUESTION 3
SANS 10142 PART 1 OF 2003

3.1 Current carrying capacity on conductors and cables.
The sustained current carrying capacity (I) measured in amps of a cable buried directly in the ground can be calculated by the following equation:
I = Is x F1 x F2 x F3 x F4 in amps.

3.1.1 Give the information of the factors used in the equation to enhance your answer in each case together with an example. (5)

The sustained current-carrying capacity I (A) of a cable buried directly in the ground can be calculated by the following equation:

$$I = I_s \times F_1 \times F_2 \times F_3 \times F_4 \text{ A}$$

where

I_s is the standard rating, in amperes;

F_1 is the rating factor for depth of burial, given in table 6.16;

F_2 is the rating factor for soil temperature at depth of burial, given in table 6.11;

F_3 is the rating factor for thermal resistivity of soil, given in table 6.12;

F_4 is the rating factor for grouping of directly buried cables that are thermally interdependent, given in table 6.13.

Thus CCC = 100 X .9 X .8 X .7 X .6
= 30,24 AMP (5)

3.1.2 Explain in your own words how the area of a cable could be determined for a certain load by using the information in QUESTION 3.1.1. (5)

Note : the answer must be summarized in point form and not be more than four lines. [10]

3.1.2 Say the load is 30,24amps

- Divide the load by each factor
- The total load is then 100amps
- Look up the cable size under table 6.8 using 100amps
- Cable size falls between 10mm² & 16mm² CU cables (5)

Note : the above is only an example , candidates may use any example.

QUESTION 4
SANS 10142 PART 1 OF 2003
(Positioning and the fixing of cables)

4

Name FIVE cases where the installation or running of a cable is prohibited.
Note: the answer must be ——————————— summerised in point form. [10]

Positioning and fixing of cables

Positioning

A cable shall not be run

a) in the same trench or wireway as a supplier's cable, except with the supplier's permission,

b) in the same wireway as the cables or wires of telecommunication, radio and signalling circuits that are not covered by this part of SANS 10142 (SABS 0142),

c) where it is likely to be damaged by liquids such as oil, acid, acetone and alkali or by gases such as sulfur dioxide,

d) within 150 mm of hot services such as hot pipes and flues if the heat is likely to damage the cable, unless the cable is cooled or shielded from heat, or

e) in a position where it is likely to be damaged, unless it is mechanically protected.

(5)

5.1 Briefly describe the methods used to determine the minimum nominal size for PVC conduit and the maximum allowable % not to be exceeded for ducting, conduit and trunking. (4)

Multicore cables in wireways

To determine the size of wireway needed to accommodate cables of different sizes, add up the overall nominal cross-sectional area of each cable and ensure that this total area does not exceed the following percentages of cross-sectional area of the wireway:

a) 40 % for conduit;

b) 35 % for ducting; and

c) 45 % for trunking.

5.2 The following information is given the following:

- 25 mm PVC conduit
- 2 x 1,5 mm² PVC conductors
- 3 x 4 mm² PVC conductors
- 2 x 6 mm² PVC conductors

Determine how many 1 mm² single core PVC conductors may be added may be added to the installation according to the code. (4)

5.2

2x 1.5mm²	= 20
3 x 4mm²	=51
2 x 6mm²	= 44
total value	115

but 25mm²can use 144 C values

thus 144 - 115	= 29C value left
but 1mm²	= 8C values
	$= \frac{29}{8}$
	=3.625

thus only 3 1mm² single core PVC conductors may be added to the 25mm PVC conduit. (4)

5.3 What are the earthing requirements regarding insulated flexible metal conduit. (2)
[10]

Shall be connected to earth but shall not be used as an earth continuity conductor. (2)

QUESTION 6
SANS 10142 PART 1 OF 2003 (6)

6.1 **Name FIVE manufacturing and construction requirements for a 10 mm² earth continuity conductor.** (9)

Earth continuity conductors

An earth continuity conductor shall

a) consist of compatible conductors,

b) if it forms part of a cable other than a flexible cable, comply with the relevant requirements of the standard for the cable,

c) if it forms part of a flexible cable, be of the same material as, and have a nominal cross-sectional area at least equal to, that of the largest phase conductor,

d) if it does not form part of a cable or flexible cable, have a nominal cross-sectional area at least equal to that determined in accordance with table 6.28, as follows:

   1) from the row of table 6.28 that gives the rated current of the overcurrent protective device, select a "length of earth continuity conductor" that most closely exceeds the actual length of the circuit;

   2) from the head of the column that gives the selected "length of earth continuity conductor", read off the minimum nominal cross-sectional area of earth continuity conductor to be used; and

e) be able to carry the prospective fault current without excessive heating of the conductor, within the disconnecting time.

6.2 **What is meant by the term 06h00 earthing requirements according to the code.** (1)
[10]

Earth continuity conductors shall be so arranged that they cannot be tampered with.

QUESTION 7
SECTION 6
INSPECTION AND TEST (INSULATION RESISTANCE TESTS)

7.1 Name SIX safety precautions that must be taken when the above test is conducted. (3)

7.1

- Ensure that the supply is switched off or at zero potential , disconnect the supply cable totally for AC & DC supply.
- Disconnect all sensitive electronic devices such as, surge arrestors earth leakage devices, SPDS if fitted, light ballast and starters, electric fences and alarms.
- Only use AC & and DC voltage of twice the RMS value of the supply. Do not exceed these voltages.
- Disconnect all external loads, do not just switch them off.
- Ensure that all fuses are in place and that all switches are on, especially when there is two way or more switching facilities.
- Always ensure that the circuit that is under test is discharged .
- Always restore the supply to normal.
- Take any other precautions were necessary.

7.2 Explain briefly how the accuracy of the test instrument can be verified?

Note: Give hypothetical values to enhance your answer. (3)

7.2

- Use two resistors of certified values for the electrical zero and range of the test.
- Example 1MΩ and 20MΩ
- Both test must be within 5% or better
- Example $\frac{1\ M\Omega \times 100\%}{1.1M\Omega} = 9.1\ \%$
- to high

7.3 What is the minimum acceptable insulation resistance reading at 23^0 C according to the code. (½)

7.3 Minimum of 1MΩ

7.4 If the insulation resistance reading test must be carried out on a three phase 4-wire system, which reading of the recorded values must be noted.

7.4 Measure all the possibilities and then record the worst reading example 1.7 MΩ between red and blue phase.

7.5 What steps must be taken if the insulation resistance test fails to comply? (1)

7.5 Sectionize each circuit to be tested to see which circuit has failed the test and repair. Note : min resistance 1MΩ

7.6 What measures could be taken if the readings fail when the test is carried out from the main DB to three other sub-DB^s. (1)

7.6 Sectional each section between feeders, any reading above 1MΩ is expectable when measured individually

7.7 Is a reading of 1,6 Giga-ohms acceptable when the test is done between the live and neutral conductors? YES (½)

QUESTION 8
SANS 10142 PART 1 OF 2003

Calculate the PSCC of a DC supply with the following information given:

- 110 cell battery of 200A/Hr
- Total internal resistance of the supply is 1,1 ohms
- Total resistance of the battery pole connectors is 1 ohm
- Total cable length 100 meters if a copper cable is used
- Cross sector area of cable 16 mm^2
- Ignore installation methods [10]

$$EB = 1{,}05 \times 2volts/cell$$
$$EB = 1{,}05 \times 2 \times 110 = 231V$$

$$PSCC = \frac{EB(AMP)}{R_{RBBR}}$$
$$PSCC = \frac{231}{(0{,}9 \times 1{,}1) + 1 + (2 \times 0{,}0014) \times 100}$$
$$PSCC = \frac{231}{2{,}27}$$
$$PSCC = 101{,}762 Amps$$

QUESTION 9
SANS 10142 PART 1 OF 2003
Surge Protection Annexure (L)

9.1 What are the installation requirements regarding surge protection device and the class group of the device. (2)

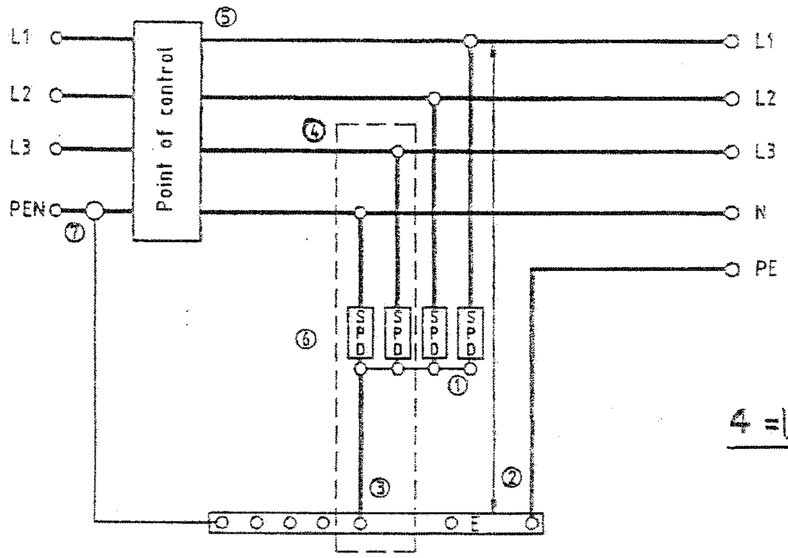
Surge protection devices should be installed at least in the main distribution board of an electrical installation.

b) SPDs in the main distribution board shall be at least class II devices;

9.2
9.2.1 Thermal disconnecting, mechanism, visual indication that shows end of (2)
9.2.2 Live conductor to the consumers earth terminal , than ,5M (2)
9.2.3 Manufacturer, not less than 6mm^2 (2)

9.2.4 Draw a simple circuit of a single phase TNCS system which are connected to a SPDS system. (2)

[10]



4 =1Ø

Figure L.1 – Installation of SPDs where the supply is a TN-C-S system earthing
Neutral and protective functions (earthing) combined in a single conductor between the source of energy and the point of supply and separated in the consumer's installation

QUESTION 10

SABS 0313 OF 1999
THE PROTECTION OF STRUCTURES AGAINST LIGHTNING
Inspection and maintenance of LPSs

10.1 Name the THREE main objectives of LPS inspections **(4)**

he objectives of the inspections are to ensure that

) the LPS complies with the design,

) all omponents of the LPS are in good condition and capable of performing their designed functions, and that there is no corrosion, and

any recently added services or construction works have been incorporated into the protected space by bonding or extensions to the LPS.

certificate of compliance shall be issued in respect of an inspected LPS.

10.2 Order of Inspections
Name FOUR inspections in order of sequence (4)

nspection of the embedded electrodes shall be carried out during the construction of the structure.

nspection shall be carried out after installation of the LPS for compliance

eriodic inspection shall be carried out to ensure compliance

dditional inspection shall be carried out after alterations or repairs or after the structure has been ruck by lightning to ensure compliance with all the requirements

10.3 Name TWO main fundamental reasons of maintenance. (2)

[10]

Regular inspections are necessary for the reliable maintenance of an LPS. The frequency of inspections will ensure that the efficiency of the LPS will be maintained, and annual inspections are recommended. All observed faults shall be repaired without delay.