2521/205
2601/205
ELECTRICAL POWER GENERATION,
TRANSMISSION AND PROTECTION
June/ July 2021
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (POWER OPTION)

MODULE II

ELECTRICAL POWER GENERATION, TRANSMISSION AND PROTECTION

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
- *answer booklet;*
- *non-programmable scientific calculator;*
- *drawing instruments.*

*This paper consists of **TWO** sections; A and B.*
*Answer any **THREE** questions from section A and any **TWO** questions from section B in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

Take: $\epsilon_o = 8.85 \times 10^{-12}$ F/m
$\mu_o = 4\pi \times 10^{-7}$ H/m
$1\ eV = 1.6 \times 10^{-19}$ J

This paper consists of 8 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: ELECTRICAL POWER GENERATION AND TRANSMISSION

*Answer any **THREE** questions from this section.*

1. (a) (i) Explain the generation of electrical power in reference to diesel power station.

(ii) State **one** function of each of the following parts of the power station in a(i).

(I) air intake system;
(II) lubricating system.

(5 marks)

(b) Draw a labelled schematic diagram of a nuclear power plant. (7 marks)

(c) A nuclear power plant of efficiency 40% supplies power to a locomotive which develops an average power of 1600 kW during an eight hour operation from one station to another. The plant uses U^{235} which on fission releases 200 MeV. Determine the number of uranium atoms consumed during the operation. (8 marks)

2. (a) (i) Explain the significance of high load factor in an electric power generation station.

(ii) Distinguish between peak and base loads of a power station.

(5 marks)

(b) (i) Define 'power factor' as used in electrical power systems.

(ii) Explain the effect of low power factor on each of the following:

(I) transmission lines;
(II) transformers;
(III) switch gear.

(4 marks)

(c) (i) Explain **two** methods used to meet increased kilowatt demand on a power station.

(ii) A consumer takes a peak load of L kW at a power factor of $\cos\phi_1$. He is charged at a rate of Sh x per kVA of maximum demand. He then improves his power factor to $\cos\phi_2$ by installing a bank of capacitors which cost him Sh y per kVAR per annum. Show that the consumer's most economical power factor is given by: $\cos\phi_2 = \sqrt{\left(1-\left(\frac{y}{x}\right)^2\right)}$. (11 marks)

3. (a) (i) State **two** properties of overhead line insulators.

(ii) Illustrate how overhead line conductors are attached to each of the following types of insulators:

(I) pin - type;
(II) suspension type.

(iii) List **two** performance tests carried out on insulators before being used on overhead lines.

(6 marks)

(b) A three phase overhead transmission line has conductors of diameter 1.2 cm, arranged at the corners of an equilateral triangle of 3 m side. Determine the capacitance of each line conductor.

(3 marks)

(c) Show that for a single overhead conductor of radius r metres carrying a current of I amperes, the flux linkages from the centre up to the conductor surface is given by $\psi = \frac{\mu_r I}{8\pi}$.

(11 marks)

4. (a) Explain **two** effects of short circuits in a power system.

(4 marks)

(b) (i) Distinguish between fusing current and, fusing factor as used in switch gears.

(ii) List any **two** types of circuit - breakers.

(4 marks)

(c) (i) Illustrate each of the following reactors in a power system:

(I) tie-bar reactors;
(II) feeder reactors.

(ii) Figure 1 shows a generating station having two alternators A and B operating at a common base of 100 MVA. Determine the amount of short circuit MVA due to a fault at point F.

(12 marks)

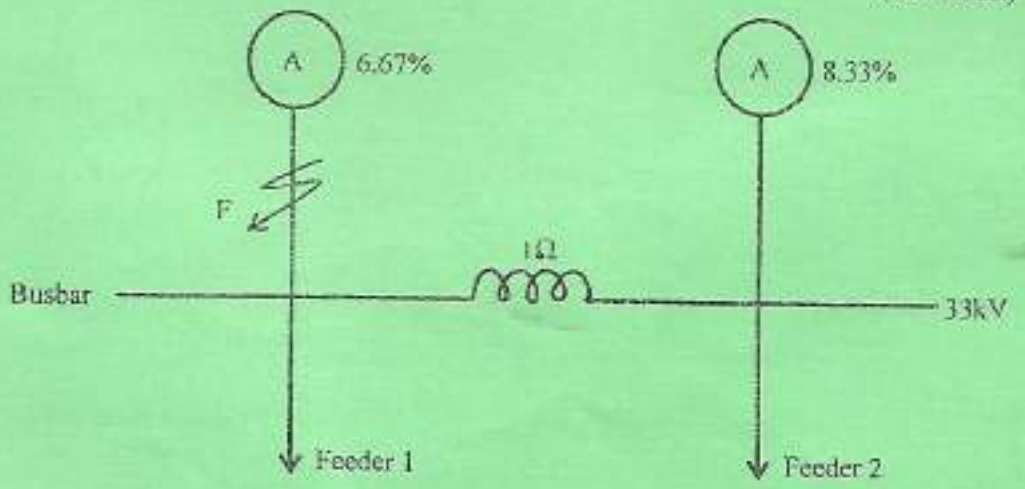


Fig. 1

5. (a) State **two** factors that determine the total cost of power transmission. (2 marks)

(b) (i) Figure 2 shows an illustration of Kelvin's law. Copy the graph and name the curves labelled 1, 2 and 3.

(ii) Indicate the position of the most economical cross-sectional area of a transmission conductor.

(4 marks)

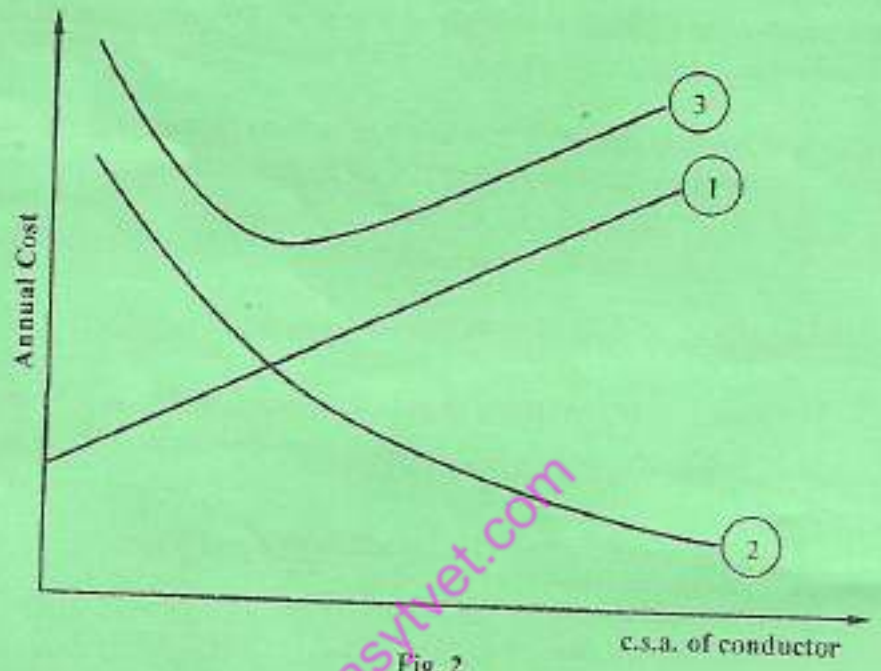


Fig. 2

(c) (i) Figure 3 shows cross-sectional views of various types of underground cables. Identify the cables *x*, *y* and *z*.

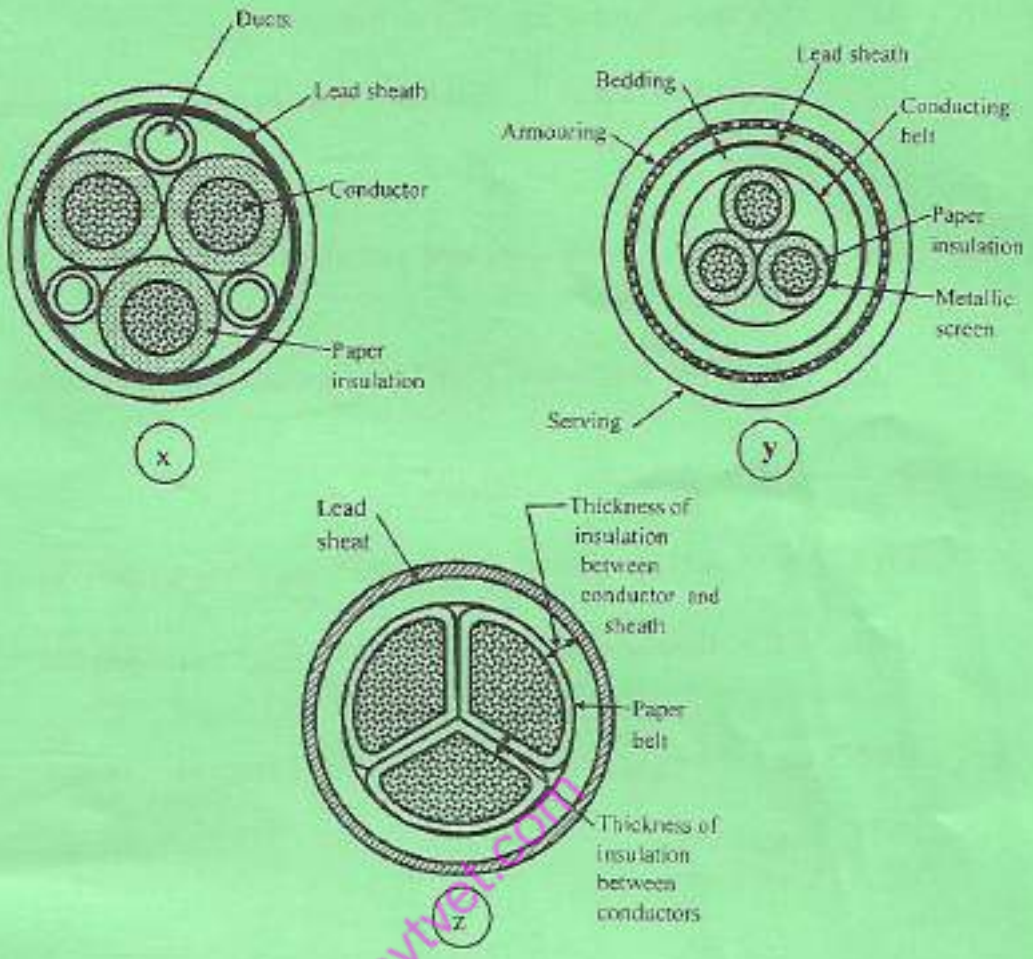


Fig. 3

(ii) List **three** methods of installing underground cables. (6 marks)

(d) (i) With aid of a diagram explain the varley loop method of locating an earth fault in underground cables.

(ii) Derive an expression for the distance of the fault from the test end in d(i).
(8 marks)

SECTION B: ELECTRICAL POWER PROTECTION

*Answer **TWO** questions from this section.*

6. (a) (i) State **two** effects of lightning strokes.

(ii) Explain **two** factors that determine whether a structure requires protection against lightning.

(6 marks)

(b) (i) List **two** metalwork associated with electrical installation which may require cathodic protection.

(ii) Explain **two** precautions undertaken in order to prevent corrosion.

(6 marks)

(c) (i) Explain 'temporary installation'.

(ii) State **two** IEE regulation requirements regarding temporary installations.

(iii) Outline **three** conditions likely to cause electric shock at a building site.

(8 marks)

7. (a) Explain each of the following as used in building services:

(i) water supply;
(ii) water treatment.

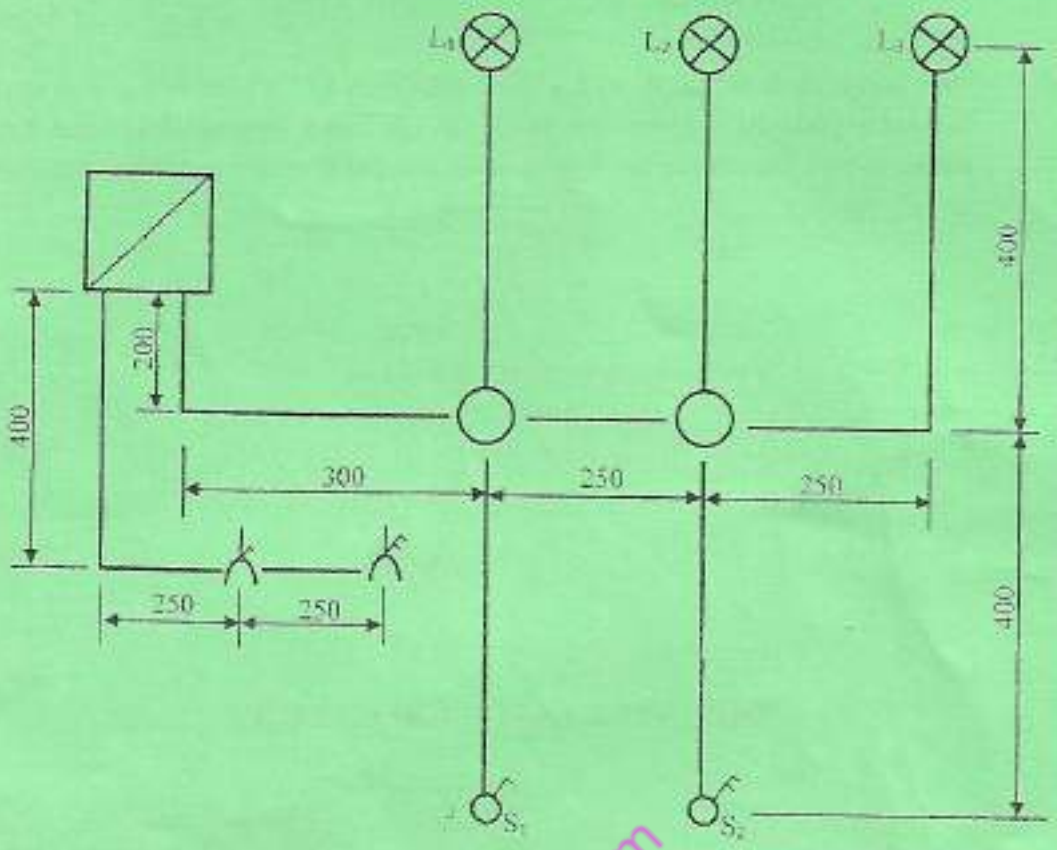
(4 marks)

(b) State **two**:

(i) merits of using conduit wiring system;
(ii) IEE regulation requirements of the wiring in b(i).

(4 marks)

(c) Figure 4 shows a schematic diagram of a PVC sheathed electrical installation.



Note: All dimensions are in mm

Fig. 4

Draw the wiring diagram such that:

(i) S_1 controls lamp L_1;
(ii) S_2 controls lamps L_2 and L_3 independently;
(iii) socket outlets are connected in radial;
(iv) estimate the quantities of materials and accessories to be used for the installation.

(12 marks)

8. (a) Define each of the following terms as used in illumination:

(i) brightness;
(ii) illuminance.

(2 marks)

(b) Explain the significance of the spacing to height ratio in the design of a lighting scheme.
(2 marks)

(c) (i) Draw a labelled diagram of a carbon filament lamp.

(ii) State **two** disadvantages of the lamp in c(i) when compared to an arc lamp.

(7 marks)

(d) Two lamps each of 500 W with a lamp efficiency of 25 lumens per watt are mounted on two lamp posts 10 m apart. The posts have different heights of 3 m and 4 m respectively. Determine the illumination at a point mid-way between the lamp posts.

(9 marks)

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