2521/205
2601/205
ELECTRICAL POWER GENERATION, TRANSMISSION AND PROTECTION
June/July 2022
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.

This paper consists of 6 printed pages.

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

Turn over

SECTION A: ELECTRICAL POWER GENERATION AND TRANSMISSION

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

1. (a) Describe each of the following as used in electric power supply:

(i) Capacity factor.
(ii) Demand factor.

(4 marks)

(b) A power station has the peak load of 30 MW. The loads having maximum demands of 25 MW, 10 MW, 5 MW and 7 MW are connected to the station. The capacity of the power station is 40 MW and annual load factor is 50%. Determine the:

(i) Average load;
(ii) Energy supplied per year;
(iii) demand factor.

(6 marks)

(c) Explain each of the following causes of low power factor:

(i) inductive loads;
(ii) variations in power system loading;
(iii) harmonic current.

(6 marks)

(d) Table 1 shows the power demand for a 1 MW generating station supplying a given region. Draw the daily load curve.

Table 1

From	To	Demand (kW)
12.00 a.m.	5.00 a.m.	200
5.00 a.m.	6.00 a.m.	100
6.00 p.m.	7.00 p.m.	600
7.00 p.m.	9.00 p.m.	900
9.00 a.m.	12.00 p.m.	600

2. (a) State any **four** factors considered when selecting a site for hydro-electric power plant.

(4 marks)

(b) Describe each of the following components of a hydro-power plant:

(i) Turbine;
(ii) Forebay;
(iii) Track rack.

(6 marks)

(c) With the aid of a labelled diagram, describe the operation of Kaplan turbine.

(7 marks)

(d) In a power plant, the steam from the boiler reaches the turbine at a temperature of 700°C. The spent steam leaves the turbine at 100°C. Determine the maximum efficiency of the turbine.

(3 marks)

3. (a) List **four** properties of insulating materials for cables used in power systems.

(4 marks)

(b) With the aid of a labelled cross-sectional diagram, explain the construction of H-type 3-core screened cable.

(6 marks)

(c) Explain the capacitance method of grading cables.

(4 marks)

(d) A 66 kV 50Hz 3-phase transmission line uses a 2 km long 3-core underground cable. Each of the core is 1.5 cm in diameter and has insulation of thickness 0.5 cm and relative permittivity of 3. Determine the:

(i) capacitance of cable per phase;
(ii) voltage per phase;
(iii) total charging kVAR.

(6 marks)

4. (a) State **four** merits of suspension insulators as used in transmission lines.

(4 marks)

(b) Explain each of the following methods of improving string efficiency:

(i) use of longer cross-arms.

(ii) grading the insulators.

(iii) use of a guarding.

(6 marks)

(c) A 100 km long, 150 kV, 400 MVA, 60 Hz, 3 - phase power transmission line has the following characteristics:

resistance; r = 0.103 Ω/km
inductive reactance ; x = 0.525 Ω/km
admittance ; y = 3.3 x 10^{-6} S/km

The line supplies rated voltage and apparent power at 0.9 power factor lagging. Determine the:

(i) per phase series impendance;
(ii) shunt admittance;
(iii) rated line current.

(8 marks)

(d) List **two** merits of aluminum overhead conductors. (2 marks)

5. (a) Define each of the following with respect to fuses:

(i) cut-off current;
(ii) pre-arcing time;
(iii) rupturing capacity

(3 marks)

(b) With the aid of a labelled diagram, explain the operation of a cross blast air circuit breaker. (7 marks)

(c) Explain the functions of each of the following elements of an excitation system:

(i) regulator;
(ii) load compensator;
(iii) limiters.

(6 marks)

(d) A 3-phase 480 V power system has a load of 6.5 kW. Determine the size of the circuit breaker needed. (4 marks)

SECTION B: BUILDING SERVICES PROTECTION

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

6. (a) Distinguish between pitting and selective dissolution types of corrosion citing an example in each case. (4 marks)

(b) With the aid of a labelled schematic circuit diagram, explain impressed current cathodic protection method of corrosion. (6 marks)

(c) Explain the uses of each of the following electrical systems on a caravan site:

(i) 240 V mains.

(ii) 12 V battery system. (4 marks)

(d) (i) Outline **four** precautions to be taken to prevent corrosion.

(ii) Describe the process of electrolyte corrosion. (6 marks)

7. (a) Define each of the following as applied in lighting protection:

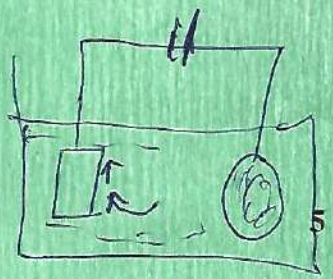
(i) upward flash;
(ii) thunder cloud. (2 marks)

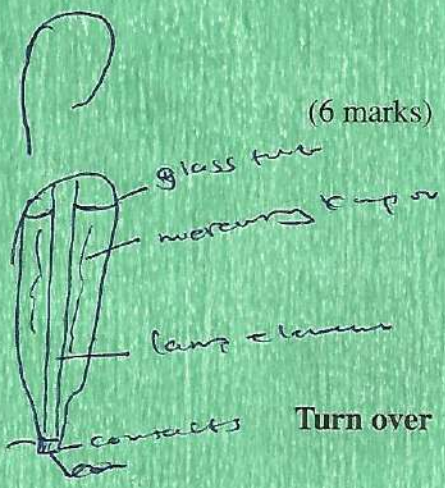
(b) Describe **three** components of a lighting protection system. (6 marks)

(c) With the aid of a labelled diagram, describe the operation of a mercury vapour lamp. (6 marks)

(d) A room of dimensions 18 m by 12 m is to be illuminated with an average illumination of 150 lux. 24 lamps are to be fitted at 6 m height. The efficiency of the lamps is 20 lumens /W with a utilization factor of 0.6 and a maintenance factor of 0.75. Determine the:

(i) total gross lumens required;
(ii) total wattage required;
(iii) wattage of each lamp. (6 marks)





8. (a) Define each of the following as used in water distribution systems:

(i) screening;
(ii) coagulation.

(2 marks)

(b) Explain each of the following water systems as used in building services:

(i) high-level reservoir;
(ii) direct pumping.

(4 marks)

(c) A wiring system consists of two light/fan circuits of 800 watts each and two 15 Amp socket circuits of 1000 watts each . If the overall power factor is 0.8 lagging. Determine the

(i) load wattage in the two light/fan sub-circuit;
(ii) load wattage in the two socket circuits;
(iii) total wattage;
(iv) total current.

(8 marks)

(d) **Figure 1** shows a installation diagram.

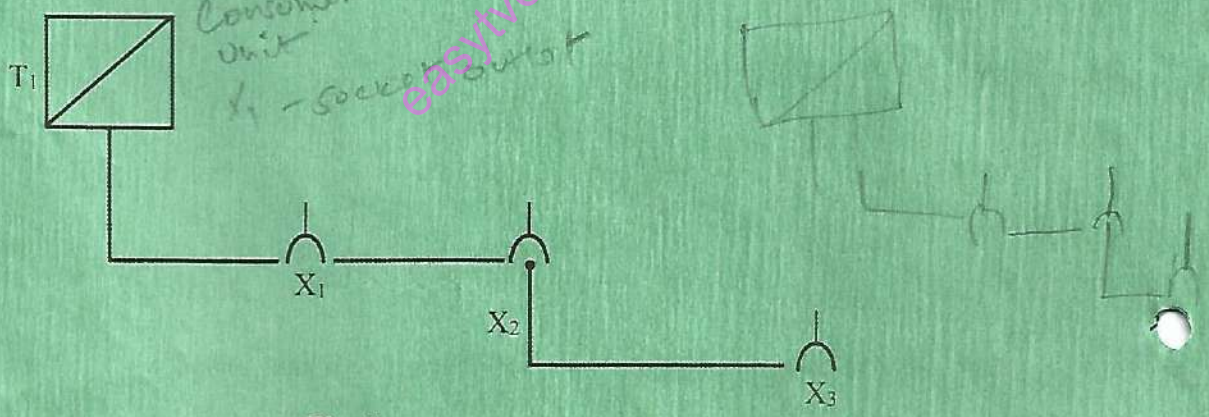


Fig. 1

(i) Identify the components T_1, and X_1

(ii) Draw a wiring diagram of the installation for a ring circuit with a spur.

(6 marks)

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