2521/205
2601/205
ELECTRICAL POWER GENERATION,
TRANSMISSION AND PROTECTION
Oct./Nov. 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 **EIGHT** questions in **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: $\epsilon_0 = 8.85 \times 10^{-12}$ F/M
$N_0 = 4\pi \times 10^{-7}$ H/M
$1eV = 1.6 \times 10^{-19}$ J

This paper consists of 7 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) State **two** merits of thermal power generation. (2 marks)

(b) Describe each of the following components of a thermal power station:

(i) boiler;

(ii) economizer;

(iii) alternator.

(6 marks)

(c) Distinguish between impulse and reaction turbines as used in steam power generating plants. (4 marks)

(d) A 500 kW steam power generating station uses coal of calorific value 6400 KCal/kg. Thermal efficiency is 40% and electrical efficiency of the station is 92%. Determine the:

(i) overall efficiency of the power station;

(ii) units generated / hour;

(iii) heat produced per hour;

(iv) coal consumption / hour.

(8 marks)

2. (a) Distinguish between each of the following as used in power generation economics:

(i) connected load and peak load;

(ii) diversity factor and load factor.

(8 marks)

(b) **Figure 1** shows a typical daily load curve for a power station. Draw the corresponding load duration curve. **(5 marks)**

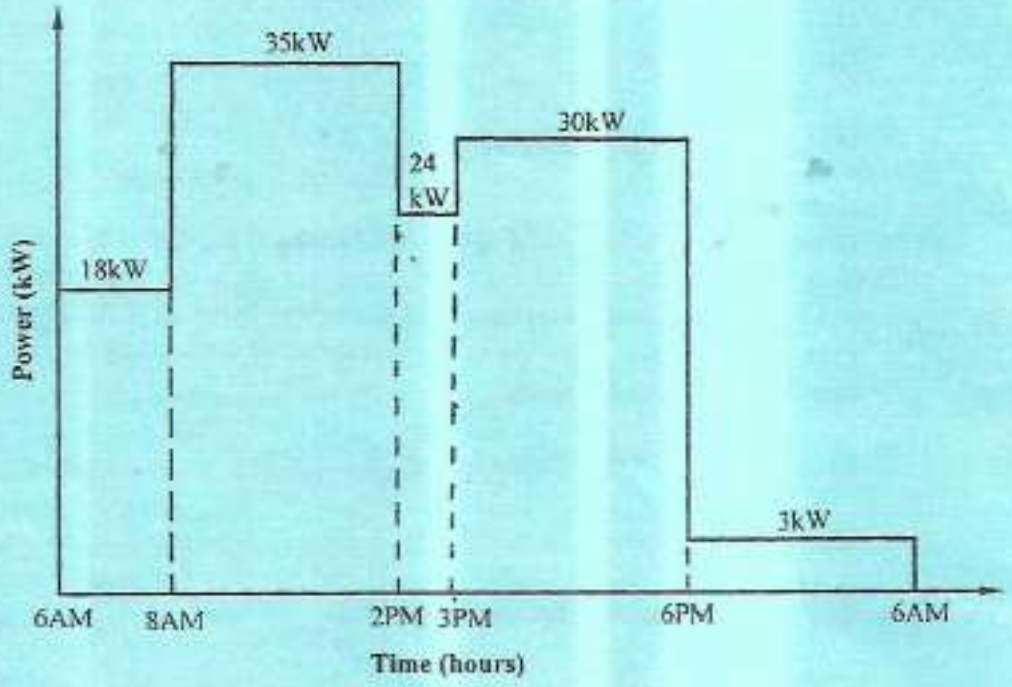


Fig. 1

(c) **Table 1** shows the daily demands of three consumers.

Table 1

Time	Consumer 1	Consumer 2	Consumer 3
12 Midnight to 8 a.m.	No load	200 W	No load
8 a.m. to 2 p.m.	600 W	No load	200 W
2 p.m. to 4 p.m.	200 W	1000 W	1200 W
4 p.m. to 10 p.m.	800 W	No load	No load
10 p.m. to midnight	No load	200 W	200 W

Determine the:

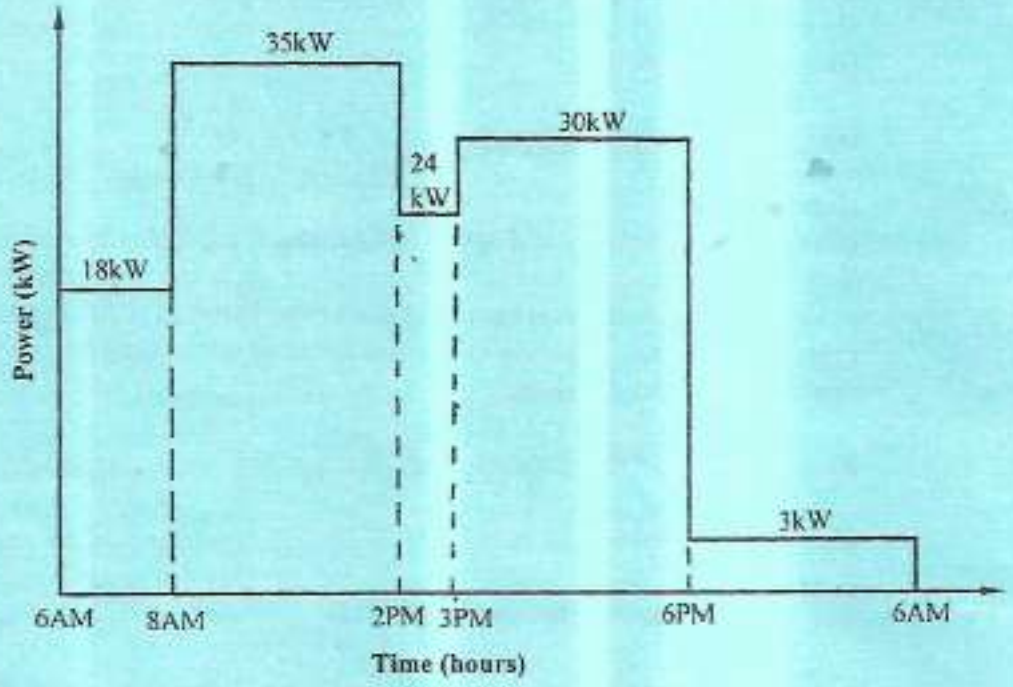
(i) maximum demand of individual consumers;

(ii) diversity factor;

(iii) load factor of the station.

(7 marks)

(b) **Figure 1** shows a typical daily load curve for a power station. Draw the corresponding load duration curve. **(5 marks)**



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10 p.m. to midnight	No load	200 W	200 W

Determine the:

(i) maximum demand of individual consumers;

(ii) diversity factor;

(iii) load factor of the station.

(7 marks)

3. (a) State **three** causes of low power factor. (3 marks)

(b) Describe each of the following methods of improving power factor:

(i) static capacitor;

(ii) synchronous condenser.

(4 marks)

(c) Draw a labelled schematic diagram of a brushless excitation system. (5 marks)

(d) A 100 kW induction motor operating at a power factor of 0.707 lagging and a 50 kW synchronous motor operating at a power factor of 0.9 leading are fed from a single phase supply. Determine the:

(i) apparent power for each load;

(ii) reactive power for each load;

(iii) power factor of the combined loads.

(8 marks)

4. (a) Explain the functions of each of the following parts of an underground cable:

(i) insulation;

(ii) bedding;

(iii) serving.

(6 marks)

(b) With the aid of a labelled cross-section diagram, explain the construction of a H-type screened cable. (8 marks)

(c) A 11 kV single core cable has a conductor cross sectional area of 0.645 cm^2 and internal diameter of sheath of 2.18 cm.
Determine the:

(i) maximum electrostatic stress;

(ii) minimum electrostatic stress.

(6 marks)

5. (a) State **three** properties of line supports used in overhead lines. (3 marks)

(b) Describe each of the following methods of improving the string efficiency of overhead line suspension insulators:

(i) grading insulators;

(ii) using a guard ring.

(6 marks)

(c) With the aid of a labelled diagram, describe the construction of SF_6 circuit breaker. (7 marks)

(d) A short circuit test on a circuit breaker gave the following readings:-

- time to reach peak re-striking voltage $= 50\mu sec$
- peak - restriking voltage = 100 kV.

Determine the:

(i) average rate of rise of re-striking voltage (RRRV);

(ii) frequency of oscillations.

(4 marks)

SECTION B: ELECTRICAL POWER PROTECTION

Answer TWO questions from this section.

6. (a) State **three** merits of using impressed current cathodic protection. (3 marks)

(b) Explain each of the following requirements on a cathodic protection:

(i) electrical continuity;

(ii) electrical isolation;

(iii) testing equipment.

(6 marks)

(c) With the aid of a schematic circuit diagram, explain the continuous neutral earthing method. (7 marks)

(d) Outline the procedure of measuring the resistance of the earth continuity conductor. (4 marks)

7. (a) Distinguish between each of the following as used in lighting:

(i) reduction factor and lamp efficiency;

(ii) mean spherical candle power and mean hemispherical candle power. (4 marks)

(b) State **two** types of lighting schemes. (2 marks)

(c) With the aid of a diagram, describe the construction of a gas filled tungsten filament lamp. (8 marks)

(d) A room 16 m x 8 m is illuminated by 100 W incandescent lamps of lumen output of 1600 lumens. The average illumination required at the work surface is 300 lux, the utilization factor is 0.5 and the depreciation factor is 1.
Determine the number of lamps required. (6 marks)

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

(i) air terminal;

(ii) arrestor;

(iii) flash over. (3 marks)

(b) Explain **three** hazards caused by lighting. (6 marks)

(c) Outline **three** IEE regulations concerning lamp holder in an electrical installation. (3 marks)

(d) **Figure 2** shows an installation diagram of a lighting circuit.

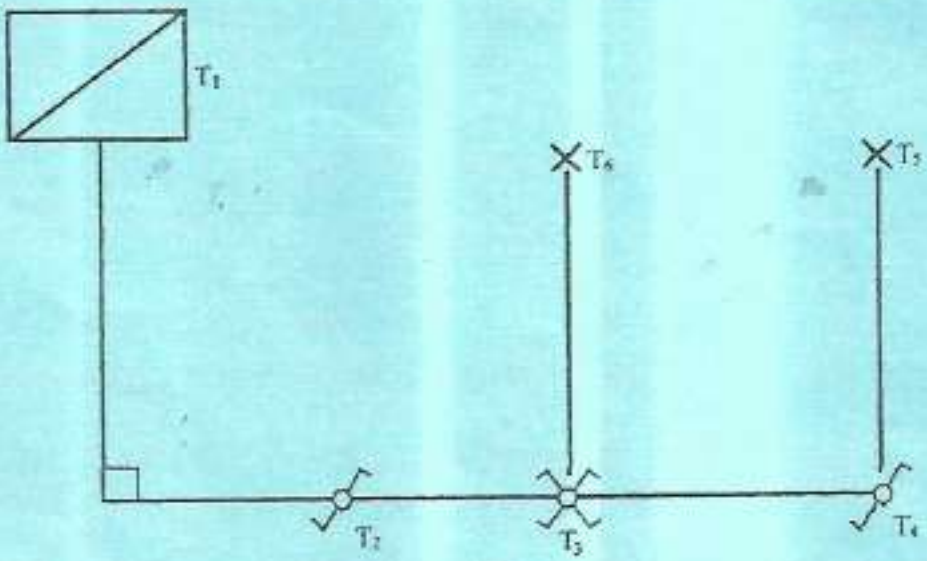

Fig. 2

(i) Name the components labelled T_1, T_2, T_3 and T_6.

(ii) Draw a wiring installation diagram such that T_6 and T_5 operate simultaneously and are controlled from three positions.

(8 marks)

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