071305T4EOP

ELECTRICAL OPERATION (POWER OPTION) LEVEL 5

ENG/OS/PO/CR/ 02 /5

Install Electrical Power Lines

November/December 2025

TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL (TVET CDACC)

WRITTEN ASSESSMENT

Time: 3 HOURS

INSTRUCTIONS TO CANDIDATE

1. This paper consists of **TWO** sections: **A** and **B**.
2. Attempt **ALL** questions in section A and **ANY THREE (3)** questions in section B.
3. Marks for each question are indicated in the brackets.
4. Candidates are provided with answer booklet.
5. Do not write on the question paper.

This paper consists of FIVE (5) printed pages

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

SECTION A (40 MARKS)

Attempt ALL the questions in this section.

1. The line support pr role in power transmission. Define transmission line support. (2marks)

2. Disruptive voltage is the minimum voltage at which the breakdown of air occurs and corona st ffects of corona on transmission line systems.(3marks)

3. Transmission conductors are the wires used to carry electricity over long distances from power stations to substations. The materials used ductors must be strong, lightweight, and good at conducting electricity. State THREE types of materials used in manufacturing transmission line supports. (3marks)

4. Materials used in making electrical poles are highly considered when it comes to selecting the right poles. List TWO advantages of steel poles over wooden poles in transmission lines. (2marks)

5. St quipment for transmission lines encompasses a range of specialized tools and devices designed to facilitate the installation and maintenance of overhead power lines. Identify TWO equipment used in mounting transmission lines. (2marks)

6. Transmission line sag is the vertical dip of an overheen its support points, which is deliberately introduced to relieve tension and prevent the line from breaking. Define transmission line sag as used in electrical transmission lines. (2marks)

7. Transmission line protection is a specialized field focused on detecting, isolating, and mitigating these faults to ensure the reliability and stability of the power system. Identify THREE components used in transmission line protection. (3marks)

8. The line support plays a ma wer transmission by keeping proper spacing between the conductors and maintaining the conductor at designed distance from its ground parts. Identify FOUR types of transmission line supports. (4marks)

9. or cable splices, are critical connections that join multiple electrical cables to extend lengths, repair damage, or link to equipment, ensuring continuous current flow. List THREE types of cable joints used in line termination. (2marks)

10. Transmission line testing is a fundamental part of maintaining the integrity of the electrical grid. Regular testing not only helps in identifying potential issues early but

also ensures that the transmission lines remain operational under varying conditions. State TWO tests carried out on a transmission installation. (4marks)

11. Grounding is gene the transmission line at the supply end to safeguard the whole system from flowing high fault currents whenever any fault occurs in the system. Differentiate between grounding and earthing. (4marks)

12. Spacing bductors is very nec essary in any power line constuction. State FOUR reasons why spacing between conductors must be carefully determined.

(4 m a r k s)

13. In transmission line protection, protection system selected should provide redundancy to limit the impact of device failure, and backup protection to ensure dependability. List THREE requirements that a protection system must satisfy. (3marks)

14. In an electric power system, switchgear is composed of electrical disconnect switches, fuses or circuit breakers used to control, protect and isolate electrical equipment.

c u u r switchgears as used in electrical transmission. (4marks)

i. Air
ii. Vacuum

SECTION B (60 MARKS)

Attempt Any THREE Questions in This Section

15. A three-phase, 230 kV, 50 Hz transmission line consists of 1·5 cm radius conductors spaced 2 m at the corners of an equilateral triangle. The condition of the wire is smoothly weathered, and the weather is fair with a temperature of 20^0C and barometric pressure. [2·148 kW]. Calculate the corona loss per km of the line.

(20 marks)

16. a) Transmission line support provides the necessary structural strength and stability. Briefly discuss the following materials as used in making transmission line supports.

(6marks)

i. Concrete

ii. Steel

o o d e n

b) Corona is a partial electrical discharge that occurs on high-voltage transmission lines when the electric field around a conductor becomes strong enough to ionize the surrounding air, leading to energy (h i s s i n g / c r a c k l i n g), r a d i o noise, and the production of ozone and n i t r o g e n o x i d e s. O u t l i n e the TWO effects of corona on high voltage transmission lines. (4marks)

c) t a g e s a c r o s s a c e r t a i n unbalanced three-phase load are given as; $E_R = 176 - j132$, $E_Y = -128 - j96$ and $E_B = -j100$, d e t e r m i n e:

i. The positive

ii. Negative

iii. Zero sequence co for the above voltages. (10 marks)

17.

a) Spacing in transmission lines is crucial because a wider distance between conductors reduces the electric field intensity, which in turn minimizes the o c c u r r e n c e of corona. With the aid of diagrams:

i. Transmission line spacing is a key factor when planning to install a new electrical line. Explain TWO importance of spacing in transmission lines.

(4 marks)

ii. Corona has both negative and positive impacts on high voltage transmission lines. State THREE effects of corona in transmission lines. (6marks)

b) A three-phase, 220 kV, 50 Hz, 100 km long overhead line consists of three stranded aluminium conductors spaced 5 m apart in equilateral formation. The surrounding air is at a temperature of 27 °C and a pressure of 740 mm of mercury. The breakdown strength of air is 3000 V/mm (Max.). Determine:

The disruptive critical voltage

i. The visual critical voltage

ii. The corona power loss of the line.

Assume the conductor diameter of 21 mm, the irregularity factor of 0.9 for the disruptive critical voltage and 0.8 for the visual critical voltage. (10 marks)

18.

a) Transmission line termination is the process of matching impedances at the ends of a transmission line using components like resistors to prevent signal reflections, which cause overshoot, undershoot, and ringing. Describe THREE components involved in the process. (6marks)

b) Phase sequence is the fixed order in which the alternating (AC) voltages in a polyphase system, particularly a three-phase system, reach their peak values. Distinguish between positive and negative phase sequence. (8 marks)

c) Efficiency testing in transmission lines involves calculating the ratio of delivered power to send power, accounting for their factors. Discuss TWO importance of efficiency testing in transmission lines. (4marks)

d) Transmission line protection plays a major role in efficiency of transmission line systems. State TWO importance of transmission line protection. (2marks)