Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	POWER TRANSMISSION AND DISTRIBUTION TECHNOLOGY
COURSE CODE	:	BNE 32703
PROGRAMME CODE	:	BNE
EXAMINATION DATE	:	JULY/AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**. 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) The power transmission line is one of the major components of an electric power system. The design of a transmission line depends on four electrical parameters which are resistance, inductance, capacitance and conductance. Explain why the resistance in transmission lines is low compared to distribution systems.

(2 marks)

(b) A three-phase overhead transmission line is supported by the insulators as shown in **Figure Q1(b)**. The potential difference across the second unit from top is 13 kV and across the third from top is 17 kV.

(i) Name the type of insulator.

(1 mark)

(ii) Draw an equivalent circuit of the insulator string.

(2 marks)

(iii) Determine the ratio of shunt capacitance to self-capacitance.

(4 marks)

(iv) Calculate the string efficiency.

(4 marks)

(c) When installing an overhead power line, ensuring the conductors are under safe tension is crucial. Excessive stretching between supports may cause the conductor to break due to increased tension, thus, allowing for a sag or dip in the conductors is typical.

(i) Describe the relationship of sag and tension in overhead lines, justify your answer with the aid of drawing.

(2 marks)

(ii) An overhead transmission line at a river crossing is supported from two towers with a 23 m difference of levels and connected between support 0.6 km apart. The conductors having a cross sectional area of 2.5 cm^2 and breaking stress of 7200 kg/cm^2. Determine the vertical sag from the taller of two support which allowed a safety factor of 4. Weight of conductor is 2 kg/m, ice and wind loading to be 1.25 kg/m and 1.85 kg/m, respectively.

(10 marks)

Q2 (a) A low power factor can cause voltage drop which can affect the performance of the electrical system. Identify the cause of low power factor and discuss the important of power factor correction to justify the improvement.

(3 marks)

(b) Determine the relationship between apparent power, active power, reactive power and power factor. Justify your answer with the aid of drawing.

(3 marks)

(c) Determine the required capacitive reactive power to raise the power factor to unity in an alternator supplying a load of 400 kW at a p.f. of 0.65 lagging. Calculate the increase in kilowatts that the alternator can supply for the same kVA loading.

(5 marks)

(d) If an installation has a power factor of 0.7 lagging and a load of 700 kW operating for 2000 hours per year and is charged at RM 100 per kVA plus 20 cent per kWh, determine the annual savings if the power factor is increased to 0.9 lagging using loss-free capacitors that cost RM 50 per kVAR. Assume an annual interest and depreciation rate of 15% for the capacitors.

(14 marks)

Q3 (a) The effective area of X-section of the conductor through which current flows is reduced due to the skin effect. Describe the factors that affect the skin effect in the conductor.

(4 marks)

(b) Calculate the loop inductance per kilometer of a single phase line consisting of two parallel conductors with a diameter of 2.6 cm and a distance of 3 meters.

(4 marks)

(c) Determine the capacitance between the conductors in a 15 km long single phase line, which the diameter of each conductor is 1.54 cm with the spacing between the conductors is 1.5 m. Then calculate the capacitance between each conductor and neutral.

(4 marks)

(d) The insulation resistance of a single-core cable is 495 MΩ/cm, find the insulation thickness.

(3 marks)

(e) The diameter of a conductor and overall diameter of a single core cable are 3 cm and 8.5 cm respectively. The insulation system comprises of 2 types of insulating materials having permittivity of 5 and 9, respectively. If the two insulating materials worked at the same maximum stress of 30 kV/cm (rms), calculate:

(i) The thickness of each layer and the safe working voltage of the cable.

(7 marks)

(ii) Safe working voltage of the cable if a homogeneous insulation of permittivity 5 is used. Give comments on your answer.

(3 marks)

Q4 (a) A circuit breaker is a device used to complete, maintain, and interrupt currents flowing in a circuit under normal or faulted conditions. Differentiate **THREE (3)** types of circuit breaker that are normally used in substation.

(6 marks)

(b) With the help of neat sketches, explain different types of distribution system.

(6 marks)

(c) A single phase distributor with a 2 kilometers long supplies a load of 120 A at 0.8 power factor lagging at its far end and a load of 80 A at 0.9 power factor lagging at its midpoint. Both power factors are referred to the voltage at the far end. The resistance and reactance per kilometer are 0.05 Ω and 0.1 Ω per kilometer respectively.

(i) Draw and clearly label the single line diagram of this AC distribution system.

(3 marks)

(ii) If the voltage at far end is maintained at 230 V, calculate the voltage at the sending end and the phase angle between voltages at the two ends.

(10 marks)

- END OF QUESTIONS –

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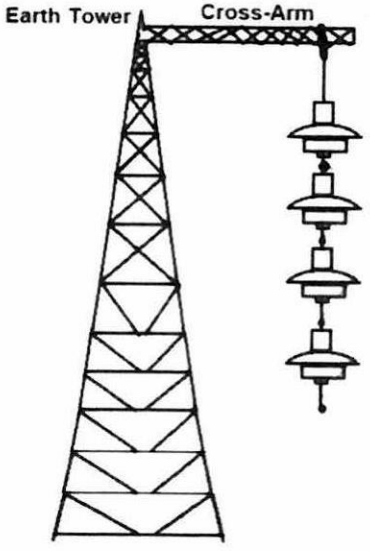

Figure Q1(b)