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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	ELECTRICAL POWER TRANSMISSION AND DISTRIBUTION SYSTEM
COURSE CODE	:	BEF 34603
PROGRAMME	:	BEV
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 (a) An underground cable is widely used to deliver the power especially in congested area. The underground cable consists of one or more conductors covered with suitable insulation and surrounded by a protecting cover. Sketch a ge neral construction of the underground cable consists of 3-conductor cables with appropriate labels.

(5 marks)

(b) A 11 kV, 50 Hz, single phase underground cable is 2.5 km long, has a conductor diameter of 20 mm and internal sheath radius of 15 mm. If the specific resistance of insulation is 5 x 10^{14} Ω-cm and the relative permittivity of insulation is 2.4, analyze:

(i) The insulation resistance

(2 marks)

(ii) Capacitance of the cable per phase

(2 marks)

(iii) Charging current per phase

(2 marks)

(iv) Total charging kVar.

(2 marks)

(c) A single core cable for 33 kV 3-phase has a conductor of 2 cm diameter and sheath of inside diameter 5.3 cm. It is required to have two inter-sheaths so that stress varies between the same maximum and minimum values in the three layers of dielectric. Evaluate:

(i) The best positions to put the inter-sheaths in the cable

(4 marks)

(ii) The voltages on each inter-sheaths

(3 marks)

(iii) The maximum and minimum stress occurs in the cable

(2 marks)

(iv) The maximum and minimum stress if the inter-sheaths are not used

(2 marks)

(v) Comment the results in **(iii)** and **(iv)**.

(1 mark)

Q2 (a) As a planning engineer, you are assigned to design the transmission lines. Point out two (2) important technical aspects that you need to consider in designing efficient transmission lines.

(2 marks)

(b) The overhead lines conductors should be supported on the poles or towers in such a way that currents from the conductors do not flow to the earth through the supports. This can be achieved by using the insulators which provide necessary insulation between the line conductors and the supports.

(i) An insulator string for 66 kV line has 4 discs. The shunt capacitance between each joint and metal work is 10 % of the capacitance of each disc. Find the voltage across the different discs and string efficiency.

(6 marks)

(ii) If the voltages across the units in a 2-unit suspension insulator are 60 % and 40 % of the line voltage, prove that the ratio of capacitance of insulator to that of its capacitance to earth is equal to 2.

(3 marks)

(c) An overhead transmission line conductor having a parabolic configuration weight 1.925 kg per meter of length. The area of cross section of the conductor is 2.2 cm^2 and the ultimate strength is 8000 kg/cm^2. The supports are 600 m apart having 15 m difference of levels. Calculate the sag from the taller of the two supports which must be allowed so that the factor of safety shall be 5. Assume that ice load is 1 kg per meter and there is no wind pressure as shown in Figure **Q2(c).**

(6 marks)

(d) (i) Skin effect is caused by magnetic flux set up due to alternating current inside the conductor. Explain the skin effect and discuss this phenomenon in d.c system.

(4 marks)

(ii) A 3-phase, 50 Hz, 275 kV overhead line has conductors placed as shown in Figure **Q2(d)(ii)**. Conductor diameter is 3 cm. Assuming the line length is 150 km, determine line to neutral capacitance per km and charging current per phase per km when the line is completely transposed. Neglect the effect of ground.

(4 marks)

Q3 (a) (i) The transmission line system has three types of lines. Point out these three lines includes the range of length of each type.

(6 marks)

(ii) A single phase overhead transmission line delivers 1000 kW at 33 kV, 0.8 p.f. lagging. The total resistance and inductive reactance of the line are 10 Ω and 15 Ω respectively. Determine:

i) Sending end voltage

(3 marks)

ii) Sending end power factor

(2 marks)

iii) Transmission efficiency

(2 marks)

iv) Comment the result in **(iii)**.

(1 mark)

(b) (i) For accurate modelling of the long transmission line system, the parameters were assume distributed throughout the line. Draw the single line diagram of the long transmission line.

(2 marks)

(ii) A three phase, 50 Hz, 150 km line has a resistance, inductance reactance and capacitance shunt admittance of 0.1 Ω, 0.5 Ω and 3 x 10^{-6} S per km per phase. The line delivers 50 MW at 110 kV and 0.8 p.f. lagging. By sketching and label the equivalent circuit that suitable for this transmission line (assume a nominal ∏ circuit for the line), determine:

i) The receiving end voltage

(3 marks)

ii) The line current

(2 marks)

iii) The sending end voltage

(2 marks)

iv) The sending end current

(2 marks)

Q4 (a) Low power factor leads to voltage depression (voltage drop) at the load bus, higher lines losses and the lower power efficiency. Utilities normally penalize the industrial customers with low power factor load. All these factors encourage the use of power factor correcting equipment.

(i) List three types of power factor correcting equipment that use widely.

(3 marks)

(ii) An alternator is supplying a load of 520 kW at p.f. of 0.6 p.f. lagging. Determine the max kilowatts the alternator supply for the same kVA loading if the power factor is unity.

(4 marks)

(iii) The improvement of power factor is very important for both consumers and generating station. Discuss the important of this improvement.

(4 marks)

(b) (i) One of the substation function is used to change AC voltage from one level to another, and change alternating current to direct current or vice versa. There are generally four types of substations. State and explain each of these types.

(8 marks)

(ii) A 2 kilometres long single phase distributor supplies a load of 120 A at 0.8 p.f. lagging at its far end and a load of 80 A at 0.9 p.f. lagging at its mid-point. Both power factor are referred to the voltage at the far end. The resistance and reactance per km are 0.05 Ω and 0.1 Ω respectively. If the voltage at the far end is maintain at 230 V, by sketching the single line diagram for the distributor AB with C as the mid-point, analyze:

i) Voltage at the sending end

(4 marks)

ii) Phase angle between voltage at the two ends.

(2 marks)

- END OF QUESTION –

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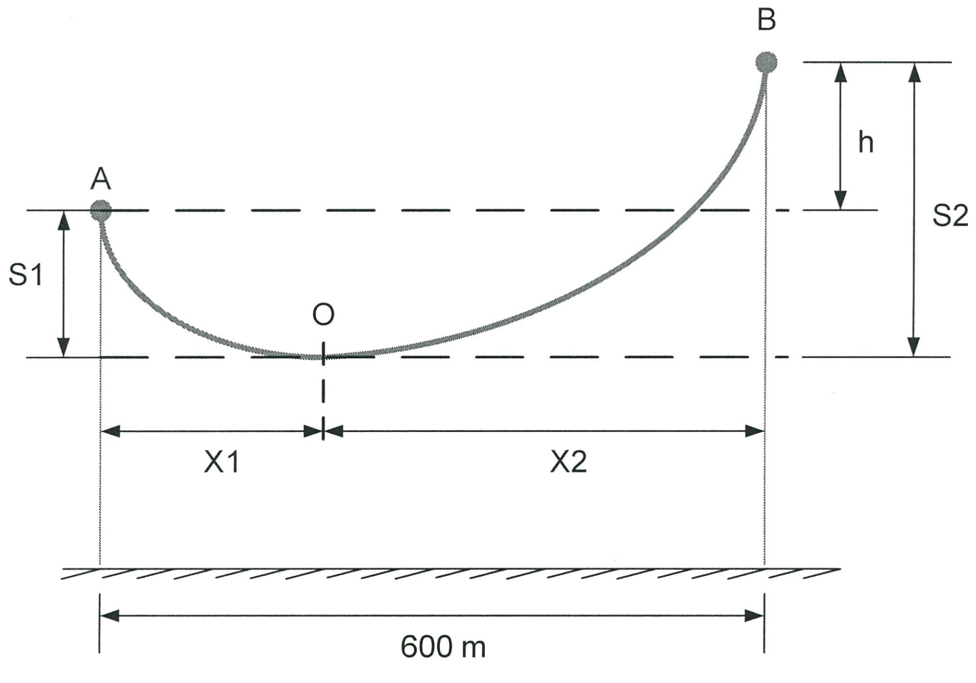

FIGURE Q2(c)

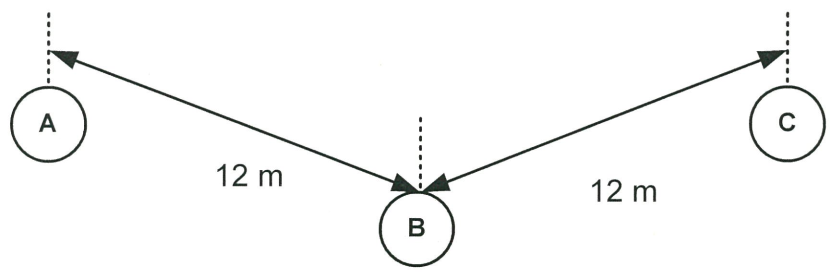

FIGURE Q2(d)(ii)

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Formula

The maximum potential gradient

$$Emax = \frac{V}{r \ln \frac{R}{r}}$$

Capacitance between core and sheath

$$C = \frac{2\pi\varepsilon_o\varepsilon_r}{ln\frac{R}{r}} \quad F/m$$

String Efficiency

$$\text{String Efficiency} = \frac{Voltage\ across\ string}{n\ x\ voltage\ across\ lower\ most\ disc}$$

Sag

$$S = \frac{wx^2}{2\text{T}}$$

Inductance of the line

$$L = 2 \times 10^{-7} ln \frac{Dm}{Ds} \quad H/m$$

Capacitance of the line

$$C_{12} = \frac{\pi\varepsilon_o}{ln\frac{D}{r}} \quad F/m$$

$$C_n = \frac{2\pi\varepsilon_o}{ln\frac{D}{r}} \quad F/m$$