



MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

SECOND SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN
ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 504: POWER TRANSMISSION AND DISTRIBUTION

DATE: 1/8/2017

TIME: 2 HRS

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) State any THREE advantages of suspension insulators. (4 marks)
- b) A string insulator for 66kV line has 3 discs and is fitted with grading ring. The capacitance from each disc to the tower is 25% of the capacitance of each unit. The capacitance between grading ring and each pin is 12.5% of the capacitance of each unit. Find the voltage across each disc and the string efficiency. (6 marks)
- c) A 220km long 3 phase, 50 Hz overhead line has a resistance of 50 Ohms per phase, inductive reactance of 75.0 ohms per phase and capacitance (line to neutral) 8.0nF per km. It supplies a load of 14.0MVA at a voltage of 100kV and a power factor of 0.8 lagging. Using nominal π circuit, calculate the sending end voltage, current and power factor. (7 marks)
- d) Derive the expression of loop the loop inductance of a single phase line. (6 marks)
- e) A 3-phase 50km long single circuit, 66kV transposed overhead line has a horizontal spacing with 3 m between adjacent conductors and 6 m between outer conductors. The conductor diameter is 2 cm. find inductance per phase. (7 marks)

QUESTION TWO (20 MARKS)

- a) State any three tests carried out on electrical insulators. (2 marks)
- b) A string insulator has four units. The capacitance from each joint to tower is 12.5% of the capacitance of each unit. It is desired that the voltage across each unit should not exceed 11kV. Find the maximum voltage for which the string can be used. (5 marks)
- c) With aid of labeled diagrams, describe short, medium and long transmission lines models. (6 marks)
- d) An overhead line has a span of 122 meters. The diameter of the conductor is 1.15 cm. calculate the sag at mid span when the conductors has an ice coating 0.96 cm thick and wind pressure is 382 N/m^2 , of the projected area. The weight of the conductor is 5.83 N/m , ice weighs 8920 N/m^3 and permissible tension is $3.56 \times 10^4 \text{ N}$. (7 marks)

QUESTION THREE (20 MARKS)

- a) State four reasons why reactive power transferred over a line should be reduced in transmission lines. (4 marks)
- b) Find the resistance per conductor per km of Markulla conductor at 20°C . The conductor size is 42 strands of aluminium of 4.13mm diameter each. Resistivity at 20°C is $2.826 \times 10^{-8} \text{ ohm-meter}$. Assume the increase in length due to spiraling is 1.5% and skin effect increase the resistance by 4%. (5 marks)
- c) With aid of diagrams discuss two ways of reducing conductor vibrations in transmission lines. (4 marks)
- d) A 3-phase overhead line delivers 75 MVA at 132kV and 0.8 pf. The series impedance of the line is $28 + j63 \text{ ohms per phase}$ and the shunt admittance $j4 \times 10^{-4} \text{ Siemens per phase}$. Using nominal-T circuit, calculate sending end voltage, current and angle. (7 marks)

QUESTION FOUR (20 MARKS)

- a) Derive the expression for the capacitance of a single phase overhead transmission line. (4 marks)
- b) A 3-phase transmission line has its conductors arranged at the corners of an equilateral triangle of 3 meters side. Calculate the capacitance of each line conductor per kilometer. The diameter of each conductor is 1.0 cm. (5 marks)

- c) A short three phase transmission line 10km long has a resistance of 6 Ohms per phase and inductive reactance of 5.0 Ohms per phase. The receiving end voltage is 11kV. The receiving end load is 1000KVA at a power factor of 0.85 lagging. Find the sending end voltage and current. (6 marks)
- d) With aid of diagrams, derive the expression of voltage rise in unloaded line, the Ferranti effect phenomenon. (5 marks)

QUESTION FIVE (20 MARKS)

- a) State TWO factors that affect the sag of transmission and distribution line conductors. (2 marks)
- b) An overhead line at river crossing is supported from two towers 20 m and 14 m above water level. The distance between towers is 250 m and conductor diameter is 1.036 cm. Find the minimum clearance between conductor and water surface and the distance of the lowest point of the conductor from lower level tower. Weight of conductor is 590kg/km, breaking load 2600kg and factor of safety 2.5. (6 marks)
- c) State any TWO methods of reducing corona loss. (2 marks)
- d) A 3-phase 220kV, 50 Hz transmission line consists of 1.5 cm radius conductors spaced 2 m apart in an equilateral triangle formation. If the temperature is 40°C and atmospheric pressure 76cm of mercury, determine the corona loss per km of the line. Take $m_0=0.8$. (4 marks)
- e) Briefly describe short-term, medium-term and long-term load forecasting and their importance to operation and planning of a utility company. (6 marks)