

THE INSTITUTION OF ENGINEERS SRI LANKA

IESL ENGINEERING COURSE

PART II EXAMINATION –JULY 2012

209 POWER SYSTEMS I

Time allowed: 03 hours

This paper contains seven questions. Answer any five (5) questions. All questions carry equal marks.

$$\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$$
$$\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$$

Question 1

- Explain the term “skin effect” with related to ac transmission
- What is the purpose of installing bundle conductors in Extra High Voltage overhead transmission lines?
- Describe briefly the effect of ambient temperature against the performance of transmission lines
- Conductor arrangement of a three-phase 50 Hz overhead transmission line is shown in figure Q1. Diameter of each conductor equals to 12.27 mm

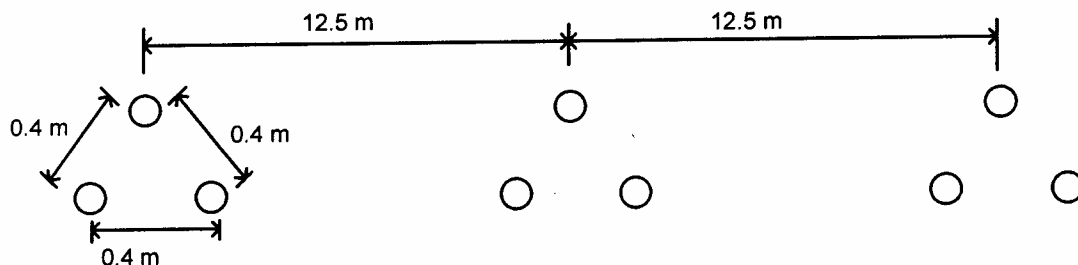


Figure Q1

- Calculate per-phase, per-unit length inductance and capacitance of the transmission line. Clearly state any assumptions that you make
- If the length of the line is 200 km long calculate the inductive reactance and capacitive susceptance for equivalent π -model of the line

Question 2

220 kV, 50 Hz, 172 km long overhead transmission line delivers power to a load of 120 MW at 0.85 power factor lagging. Per-phase, per-unit length parameters of the line are

$$R=0.125 \text{ Ohm/km}$$

$$X=0.49 \text{ Ohm/km}$$

$$Y=3.3 \times 10^{-6} \text{ S/km}$$

- Calculate **A,B,C,D** constants of the line
- If receiving end voltage to be maintained at 220 kV, determine the sending end voltage and current
- Calculate the voltage regulation and transmission efficiency

Question 3

A generator G delivers power to a large system which can be considered as an infinite bus via transformer T and double circuit 220 kV transmission line L as shown in figure Q3. Parameters of the elements of system on equipment base are

G: 250 MVA, $V=15.75 \text{ kV}$, $x_d''=0.2 \text{ p.u.}$

T: 250 MVA, 242/15.75 kV, $x=0.11 \text{ p.u.}$

L: line length =200 km; $x=0.4 \text{ Ohm/km}$

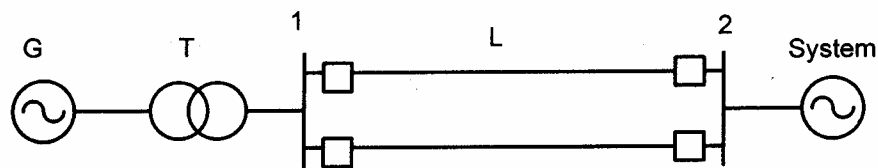


Figure Q3

- Calculate parameters of the system elements on common base of 200 MVA and 220 kV in line L
- A three-phase short circuit with zero fault impedance occurs at the midpoint of one of the transmission lines. Calculate
 - Short circuit current in kA
 - Current through generator in kA during fault

Question 4

Consider the system shown in figure Q4. Positive, negative and zero sequence reactances of system elements on common base is given in table Q4

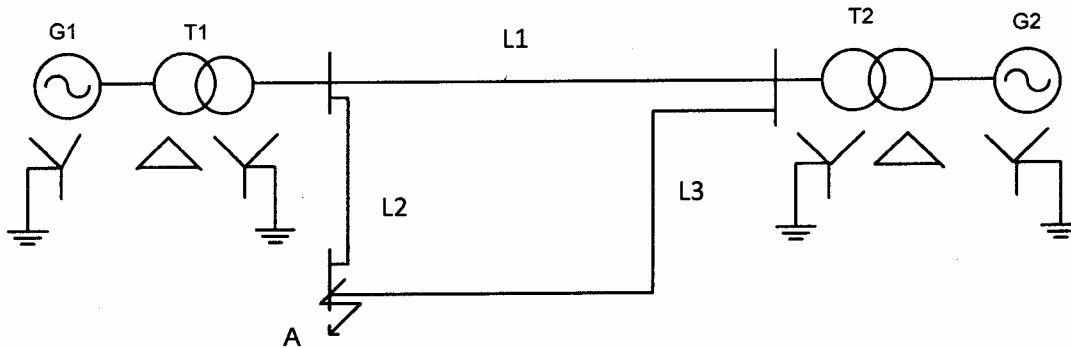


Figure Q4

Table Q4

	X_1 (p.u.)	X_2 (p.u.)	X_0 (p.u.)
G1	0.1	0.1	0.05
G2	0.05	0.05	0.025
T1	0.05	0.05	0.05
T2	0.025	0.025	0.025
L1,L2	0.1	0.1	0.25
L3	0.15	0.15	0.35

- (a) Sketch the positive, negative and zero sequence networks
- (b) If a single line to ground (L-G) fault occurs at bus A, what would be the fault current?

Question 5

- (a) Explain briefly the function of following elements in power systems
 - I. Circuit breaker
 - II. Isolator
 - III. Earthing switch
 - IV. Lightning arrester
 - V. Current transformer
 - VI. Voltage transformer
- (b) Explain briefly the following terms related to the circuit breaker
 - I. Rated short circuit making current
 - II. Rated short circuit breaking current

III. Rated Operating sequence (duty cycle)

- (a) Explain briefly the arc extinguishing mechanism of following circuit breakers
- I. Air Break circuit breaker
 - II. Minimum Oil circuit breaker

Question 6

- (a) List the main factors that has to be considered when type of power plant is selected
- (b) Sketch block diagram of a coal power plant and explain function of each element
- (c) Why coal power plant is not dispatched load during peak period?
- (d) State the advantages of a nuclear power plant over fossil fuel fired thermal power plant?
- (e) Describe how the operation of a pumped storage power plant improves the load factor of a power system

Question 7

- (a) List the various methods of voltage control at load busses and explain one of them briefly
- (b) Explain why the power systems are not allowed to operate beyond permissible range of voltage limits
- (c) Explain why the zero sequence current does not flow for faults not involving ground
- (d) Explain briefly the different types of electricity tariff used in Sri Lanka
- (e) Certain electrical consumer's monthly energy consumption is 600 kWh. Load factor of the consumer is 40%. Electricity tariff structure applicable for the consumer is as given below:

Rs. 300 per kW for the maximum load

Rs. 11.00 per kWh for the consumed energy

- I. Calculate monthly electricity bill for the consumer
- II. Compute the average cost per kWh consumed