

Tutorial 1 (Distribution Network Configuration)

Answer 1)

In Singapore, customers' installations are connected at the following voltages:

- (a) Transmission Voltage 66kV and 230kV
- (b) Distribution Voltage of 230V, 400V, 6.6kV, 22kV (may vary within +/- 6%)

The supply voltages are classified in the following categories:

- (a) Low Tension (LT) refers to 230V, single phase and 400V, 3 phase.
- (b) High Tension (HT) refers to 22kV and 6.6kV
- (c) Extra High Tension (EHT) refers to 66kV
- (d) Ultra-High Tension (UHT) refers to 230kV

Frequency of supply is 50Hz, it may vary within +/-1%

Answer 2)

Total electricity bill = \$73,523

Answer 3)

2 numbers of 22kV feeders will be provided.

Answer 4)

Minimum 4 years of practical experience is required.

Tutorial 2 (Electric Shock protection)

Answer 1)

- (i)  $Z_s = 0.681\Omega$
- (ii) the tripping time is 0.027 s
- (iii)  $I = 5.9\text{mA}$
- (iv) The CPC cables meet the thermal requirement

Answer 2)

$V_t$  without bonding = 38.95 V

$V_t$  with bonding = 0.95 V

Answer 3)

- (i)  $1.5\text{mm}^2$
- (ii) The thermal constraint is not satisfied

Tutorial 3.1 (Load Estimate)

Answer 1)

63A Three Pole circuit breaker

Answer 2)

Size of Breaker = 100A TP

Tutorial 3.2 (Fault Calculation)

Answer 1)

- (a) The base voltages are 11kV / 66kV / 22 kV
- (b) The per unit capacities of the equipment are
  - (i) Generator : 1.0p.u.
  - (ii) Transformer 1: 0.6p.u.
  - (iii) Transformer 2: 0.4p.u.
- (c) The new per unit impedances are:
  - (i) Generator: 0.1p.u. (no change)
  - (ii) Transformer 1:  $0.06 \times 5/3 = 0.1\text{p.u.}$  (no change in  $V_B$ )
  - (iii) Transformer 2:  $0.06\text{p.u.} \times 5/2 = 0.15\text{p.u.}$  (no change in  $V_B$ )

Answer 2)

- (ii)  $I_{FL} = 131\text{A}$
- (iii) (a) Fault current flowing in cable = 1186 A
- (b) Fault current supplied by the generator = 19.57 kA

Answer 3)

Breaking capacity must be at least = 28,342A

Tutorial 4.1 (Cable size and voltage drop)

Answer 1)

- (i) Design current = 34A, therefore, choose 40A circuit breaker
- (ii) Cable size =  $10\text{mm}^2$
- (iii) Cable is protected

Answer 2)

- (i) Design current = 54.1, choose 63A TPN
- (ii) Voltage drop = 4.06V

Answer 3)

Yes, 3x70 sq mm is acceptable

Tutorial 4.2 (Emergency Power Supply)

Answer 1)

Case 1: Capacity of generator must be minimum 213.75 kVA, choose 250 kVA generator

Case 2: Capacity of generator must be minimum 184.2 kVA, choose 200kVA generator

Tutorial 5 (Lightning protection)

Risk due to physical damage =  $1.29 \times 10^{-6}$

Tutorial 6 (Compensation of reactive Power)

Answer 1)

The rating of the capacitor bank = 456 kVAr

Answer 2)

The rating of the capacitor bank = 104.2 kVAr

Answer 3)

savings per month = \$88,358