TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2082 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV/ II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE 754)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*



1. For each of the following statements, state whether it is TRUE or FALSE and provide brief justification for your answer.
   a) Lightning Arrestor (LA) rating of overhead transmission line is independent of the system neutral grounding condition. [1+3]
   b) Conductor to conductor vertical spacing at a transmission line tower depends on the conductor swinging due to wind force. [1+3]
   c) The effective way to increase corona inception voltage is to increase the conductor size. [1+3]
   d) The simulation method of load forecasting is more suitable for a small area load forecast. [1+3]
2. a) What are the advantages and disadvantages of an interconnected system? [4]
   b) Discuss the economic and technical criterion to be considered while selecting the size of the standard voltage level and number of circuits for transmission line design. [8]
   c) Show that for an EHV transmission line, use of double earth wires can reduce the tower height. [4]
3. a) Derive the expression relating conductor tension to temperature for an overhead transmission line including the effects of elastic extension. [6]
   b) An overhead transmission line uses a "Lion" ACSR conductor with a span of 300 m and supports at the same level. The conductor is subjected to two loading conditions as given in the table below. Determine the horizontal tension in the conductor under the easiest condition. [8]

| Condition | temperature | ice thickness | wind pressure | horizontal tension |
|---|---|---|---|---|
| Toughest condition | 0°C | 1 cm | 80 kg/m² | Factor of safety 2 from UTS |
| Easiest condition | 75°C | No ice | No wind | ? |

Consider the following:
Ice density: 900 kg/m$^3$
Conductor modulus of elasticity: $7.0 \times 10^5$kg/cm²
Conductor coefficient of linear expansion: $19 \times 10^{-6}$per °C
Refer Conductor table for other relevant data

4. a) Compare the following with the necessary diagram: [2×4]
   (i) Radial and Loop distribution system.
   (ii) American and European distribution system.

b) Two distribution load centers operate at the same voltage level and supply the same total load, but their low-tension (LT) line configurations differ as follows: [8]

- Load Center 1: 4 LT feeders, each of 1 km
- Load Center 2: 2 LT feeders, each of 2 km

Assuming the load is uniformly distributed along the feeders and same conductors for all feeders, compute the ratio of the percentage power losses in the LT lines of Load Centre 1 to that of Load Centre 2.

5. a) How does consumer classification affect load forecasting in distribution systems? [4]
   b) A daily load pattern of a particular load center is given in table. Calculate, [8]

   (i) daily loss of load factor
   (ii) if % peak power loss is 7%, determine the % energy loss.

| Time (hr) | 0-6 | 6-10 | 10-18 | 18-22 | 22-24 |
|---|---|---|---|---|---|
| Demand (p.u) | 0.2 | 0.5 | 0.2 | 1 | 0.2 |

c) Discuss the criteria and procedure for selecting the location, capacity, and primary voltage of a distribution transformer in a distribution system. [6]

***

$\xi_{loss} =$

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2082 Shrawan**

| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE 754)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. State whether the following statements are TRUE or FALSE, also justify your answers with brief explanation.
   a) The other thing remaining the same, the Basic Insulation Level (BIL) of overhead line insulator increases with increase in neutral impedance. [1+3]
   b) HVDC transmission stations does not require reactive power support. [1+3]
   c) A single-phase earth return distribution system is very much suitable for densely populated areas with high load density. [1+3]
   d) Corona is more dominating design criterion for LV Transmission lines. [1+3]
2. a) For a 220 kV double circuit transmission line, compute the following air clearances. Assume the maximum swing angle of the insulator string as $30^0$. Also derive any expression used. [8]
      (i) Cross arm length
      (ii) Insulator string length
      (iii) Vertical separation of conductor
      (iv) Height of earth wire from the topmost conductor
   b) Discuss the role of system (neutral) earthing in the selection of overhead line insulation level. [8]
3. a) Derive the expression for maximum sag and location at which maximum sag will occur for a given span with equal supporting tower heights. [8]
   b) For a three-phase 50Hz transmission line to deliver 100 MW of power over 80 km, 132 kV single circuit line the vertical separation between the conductors (y) is 5 m and the horizontal spacing between the conductors (c) is 9 m. Suggest the best suitable conductor which meets following technical criterion: [10]
      (i) Satisfy the thermal limit (ampacity).
      (ii) Efficiency of the line not to be less than 94%.
      (iii) No corona in fair weather condition.
      (For conductor selection, a standard ACSR conductor table is provided)
4. a) Highlights the characteristics of urban and rural distribution systems from design aspects. [4]
   b) Compare the advantages and disadvantages of radial and loop distribution system. [4]
   c) A particular load center has a peak demand of 40 kW at pf of 0.85 lagging. The distribution transformer having 200 Watt iron loss and 480 W copper loss is used to supply four 3 phase LT feeders at 380V of equal length of 1.5 km each. If LT feeder conductor has resistance and reactance of 0.9 Ω/km and 0.25 Ω/km, determine percent distribution loss. [8]

5. a) A particular distribution load center consists of four 3-phase LT lines. Compute the percentage LT power loss of the load center. Given; [8]
   - Load center Peak demand: 60 kVA at a power factor of 0.9
   - The distribution LT line voltage: 380V
   - Conductor resistance: 0.5 Ω/km
   - Length of LT lines: two of 1 km each and the other two of 2 km each
   - Assume load is uniformly distributed along conductor length.

   b) Describe the general criterion that should be taken in to consideration for distributor route selection. [6]

***

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2081 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV/ II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE 754)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. State whether the following statements are TRUE or FALSE, also justify your answers with brief explanation.
   a) For transmission line of 400 kV and beyond voltage level, horizontal configuration of conductors is general choice. [1+3]
   b) Increasing the maximum allowable conductor temperature results in an increase in conductor cost and a decrease in the tower cost. [1+3]
   c) In practical cases, Loss of Load factor (LLF) is less than Load factor (LF). [1+3]
   d) The X/R ratio of distribution system is higher than transmission system. [1+3]
2. a) With suitable mathematical aid and assumptions, show that the most economical voltage increases with an increase in the length of the transmission line and/or power to be transmitted. [6]
   b) Discuss the criterion for single and double earth wire selection for a high voltage overhead transmission line. [6]
   c) State and prove Kelvin's law of most economical conductor size. Explain its limitation. [4]
3. a) Derive the expression for maximum sag and location at which maximum sag will occur for a given span with unequal supporting tower heights. [6]
   b) Compute the most economical span for a single circuit 132 kV transmission line with single earth wire using the following data. [12]

   Minimum ground clearance: 6.2 m
   Conductor to conductor vertical separation: 4.2 m
   Height of earth wire above the topmost conductor: 7 m
   Ultimate tensile strength of conductor: 18,000 kg
   Ultimate tensile strength of earth wire: 6,000 kg
   Factor of safety for toughest condition tension: 2
   Easiest condition tension in the conductor with respect to span;

| Span (m) | 250 | 275 | 300 | 325 | 350 |
|---|---|---|---|---|---|
| Easiest condition tension (kg) | 4300 | 4400 | 4500 | 4600 | 4700 |

   Weight of conductor: 2 kg/m
   Wind pressure: 100 kg/m$^2$
   Conductor diameter: 3 cm
   Diameter of earth wire: 1 cm

   Tower weight (tons) = 0.000631 $H\sqrt{B.M. \times F.S.}$ (H in meter & B.M. in kg-m). Consider 80% horizontal tower (maximum angle deviation of $2^0$) and 20% angled tower (maximum angle deviation of $30^0$)

4. a) A particular load center has a peak demand of 50 kW at a power factor of 0.8 lagging. For the following two cases of 3 phase LT feeder configuration at distribution transformer, compute the percentage of peak power loss and maximum percentage voltage drop in LT. [8]

   (i) Option 1: 4 feeders each of length 2 km

   (ii) Option 2: 2 feeders each of length 4 km

   The resistance and reactance per phase of LT conductors are 1.1 Ω/km and 0.25 Ω/km. Assume uniformly distributed load along the feeders. The distribution transformer is rated 11/0.4 kV.

   b) Discuss the primary consideration to be given while selecting a distribution transformer size and location. [8]

5. a) Discuss the advantages of ABC conductors used as LT lines. [2]

   b) What are the different methods of load forecasting? Describe briefly. [4]

   c) A 11/0.4 kV, 100 kVA distribution transformer has no load loss of 210 W and rated copper loss of 340 W. Determine the percentage monthly energy loss of the transformer if the peak demand is 50 kVA at a power factor of 0.9 and load factor of 0.3. Given: $LLF = k_1LF+k_2LF^2$ [8]

***

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
2081 Shrawan

| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

*Subject:* - Transmission and Distribution System Design *(EE 754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. State whether the following statements are TRUE or FALSE, also justify your answers with brief explanation. [4x4]
   a) Multiplying factor depends on the voltage level of the transmission line.
   b) The height of tower for an EHV overhead transmission line would be different for the choice of single earth wire and double earth wire.
   c) As temperature increase the sag in the conductor increase.
   d) While designing distribution system, transformer size is determined first before studying the feeder load characteristics.
2. a) Suggest the most economical and technically adequate suitable standard voltage and number of circuits for a 3-phase overhead transmission line delivering power of 150 MW over a distance of 170 km. [8]
   b) For a 132kV double circuit transmission line, suggest the dimensions for the following: (Take max. Swing of insulator as: 45°) [8]
   (i) Cross arm length
   (ii) Insulator string length
   (iii)Horizontal and vertical separation of conductors
   (iv)Height of earth wire from the top most conductor
3. a) A Compute the most economical span for the design of a double circuit transmission line with a double earth wire. The necessary data and the design assumptions are as follows:
   - The maximum working tension and the conductor diameter for power conductor is 6890kg and 25.97mm respectively, that for earth wire is 3332kg and 14.6mm respectively.
   - Wind force is 100 kg/m$^2$ and the cost of steel used in tower = Rs.150000 per tonne

| Span Length | Sag (m) | H1 (m) | H2(m) | H3 (m) | Ht (m) |
|---|---|---|---|---|---|
| 300 | 5.091 | 12.2 | 15.14 | 18.07 | 28.67 |
| 325 | 6.02 | 13.13 | 16.06 | 19 | 29.6 |
| 350 | 7.03 | 14.14 | 17.07 | 20.01 | 30.61 |

   Assume: Maximum conductor deviation of 80% for tower A, 15% for tower B and 5% for tower C. [10]
   b) What is a stringing chart? Derive the expression used to prepare a stringing chart. [6]

4. a) Why distribution system planning is important? Explain with steps followed in distribution system planning. [6]

   b) Compute the power loss for a 400 V, 3-phase secondary distribution line with sending end power of 10 kVA at a power factor of 0.9. Consider that the line length is 2 km long and resistance of the conductor used in the line is 0.6 ohm/km. Assume uniformly distributed loading along the line. [8]

5. a) What is an aerial bundle conductor (ABC)? Discuss the advantages and disadvantages of ABC cable in LT distribution system. [6]

   b) Briefly discuss the various types of electric load forecasting based on time horizon. [6]

   c) Explain the suitability of single phase and three phase distribution transformers. [6]

***

**Examination Control Division**
2080 Chaitra

| | | | |
|---|---|---|---|
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

*Subject:* - Transmission and Distribution System Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary table is attached herewith.***
- ✓ *Assume suitable data if necessary.*



1. State whether the following statements are TRUE or FALSE, also justify your answers with brief explanation. [4×4]
   a) Ampacity of a conductor decreases with an increase in ambient temperature.
   b) Lightning over voltage is more dominating in distribution system than in transmission system.
   c) A distribution transformer operating at significantly under-loading conditions is always beneficial from energy loss prospective.
   d) The average consumption in the feeder must be almost near to the peak demand.
2. a) Compute the number of insulator discs required for a single circuit, 220 kV, 50 Hz overhead transmission line considering the various external and internal over voltages. Use the related data given in the appendix. [8]
   b) Select the most economical and technically adequate voltage level and the number of circuits for a transmission line to transmit 190 MW of power over 240 km. Assume pf as 0.96. [8]
3. a) A particular ACSR conductor has the current carrying capacity of 400 A at an ambient temperature of $35^0$C and maximum allowable temperature of $80^0$C. Compute the current carrying capacity of the same conductor if the ambient temperature and maximum allowable temperatures will be $40^0$C and $75^0$C respectively. Also compute the conductor temperature if the conductor carries the current of 320 A. [6]
   b) Derive the relation between LLF and LF considering a suitable load curve. [6]
   c) Discuss the essential characteristics of a conductor for an overhead transmission line. Compare the performance of aluminum and copper conductors in this regard. [4]
4. a) Discuss the steps together with the data required for demand forecasting at a distribution system load center level. [8]
   b) A distribution transformer of 25kVA with no-load loss of 72W and rated Copper loss is 300W. Consider the demand for the transformer is 20 kW and the monthly energy sell equals 4800 units @ 0.85 power factors. Use Loss of Load Factor ($LLF$) = $0.3LF + 0.7LF^2$. Find the percentage energy loss. [8]
5. a) Compare the features and suitability of the underground and overhead distribution systems. [6]
   b) List and explain the various consideration to be made while selecting distribution transformer location, primary and secondary voltage level and layout. [6]
6. With respect to a distribution system, define the following terminologies: [4]
   a) Distribution transformer
   b) Load center
   c) Secondary distribution
   d) Primary distribution

## Appendix-A

I. Must economical Voltage empirical formula: $5.5\left[\frac{Lt}{1.6}+\frac{P\times1000}{\cos\phi\times Nc\times150}\right]^{0.5}$ Lt in km and P in MW

II. Standard Voltage : 66 kV, 132 kV, 220 kV, 400 kV

III. Table-A-1 Transmission line capability curve with assumption of single circuit transmission line surge impedance of 400 Ω

| length (km) | multiplying factor* |
|---|---|
| 80 | 2.75 |
| 160 | 2.25 |
| 240 | 1.75 |
| 320 | 1.35 |
| 480 | 1.0 |
| 640 | 0.75 |

* m.f.= power transmission Capability /SIL

IV. Table-A-2 Withstand voltage capability for different system voltages.

| Maximum system Voltage | 1 Minute Dry withstand (kV) | 1 Minute Wet withstand (kV) | Impulse withstand (kV) |
|---|---|---|---|
| 123 | 215 | 185 | 450 |
| 145 | 265 | 230 | 550 |
| 255 | 435 | 395 | 900 |
| 420 | 760 | 680 | 1550 |

V. Table-A-3 Flashover voltages for 254 x 154 mm disc insulators

| No. of Discs | 1 Minute Dry FOV (kV) | 1 Minute Wet FOV (kV) | Impulse FOV (kV) |
|---|---|---|---|
| 1 | 80 | 50 | 150 |
| 2 | 155 | 90 | 255 |
| 3 | 215 | 130 | 355 |
| 4 | 270 | 170 | 440 |
| 5 | 325 | 210 | 525 |
| 6 | 380 | 250 | 610 |
| 7 | 435 | 290 | 695 |
| 8 | 485 | 330 | 780 |
| 9 | 535 | 370 | 860 |
| 10 | 585 | 410 | 945 |
| 11 | 635 | 450 | 1025 |
| 12 | 685 | 485 | 1105 |
| 13 | 730 | 520 | 1185 |
| 14 | 775 | 555 | 1265 |
| 15 | 820 | 590 | 1345 |
| 16 | 865 | 620 | 1425 |
| 17 | 910 | 650 | 1505 |
| 18 | 955 | 680 | 1585 |
| 19 | 1000 | 710 | 1665 |
| 20 | 1045 | 740 | 1745 |

VI. Minimum air clearance: 6.5 inch per 10 kV(rms) and factor of safety = 8 inch

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2079 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE 754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

1. State and justify whether the following statement are TRUE or FALSE. [(1+3)×4]
   a) The value of Protection ratio (PR) increases on increasing system voltage for designing purpose.
   b) Power transfer capability of a transmission line increases with increase in line length.
   c) While designing the long transmission line, if the stability criterion is met then the thermal criterion is also met.
   d) In rural distribution it's good practice to go for higher primary distribution voltage than usual.

2. a) For a 220kV single circuit transmission line, suggest the dimensions for following: [8]
   (i) Cross arm length
   (ii) Insulator string length
   (iii) Horizontal and vertical separation of conductors
   (iv) Number of earth wires
   (iv) Height of earth wire from the top most conductor.
   (Take maximum Swing of insulator as: 45°)

   b) A double circuit, 220 KV, 50 Hz, three phase transmission line is designed to carry 144 MW for 130 KM. The line constants are given as: [10]
   R = 0.0544 Ω/km ( at Max allowable temp.)
   L = 0.494 mH/ km
   C = 23.1 nF/km

   Calculate the following:
   a) Transmission line efficiency
   b) Percentage of voltage Regulation
   c) Value of receiving end voltage rise at no load if sending end voltage is held constant.

   Suggest the options to get efficiency > 94 % and voltage regulation < 12%

3. a) What do mean by corona? Derive the expression for corona inception voltage. [6]

   b) For the transmission line design following computations has been made. Select the most economical conductor

| | A | B | C |
|---|---|---|---|
| Conductor | Tower cost / km (1000 Rs.) | Total conductor cost/km (1000 Rs.) | Annual energy loss/km (1000 kW/hr.) |
| Goat | 890 | 1254 | 32 |
| Sheep | 946 | 1450 | 30 |
| Zebra | 984 | 1585 | 28 |
| Deer | 910 | 1663 | 20 |

Using the following data.
Energy rate = Rs 9 per unit  Interest rate = 14%  Project life = 25 years [8]

4. a) Discuss the primary consideration to be given when selecting a load centre and distribution Transformer while designing a grid extended rural and urban distribution. [6]

   b) For same load density of the load centre and same conductor what will be the change in power loss by doubling the length of the line? [4]

   c) Discuss the comparative assessment for the followings. [6]

      (i) Radial and Loop Distribution system
      (ii) Overhead and Underground Distribution system

5. a) A 3-phase transformer of 100 KVA supplies a load of 75 KVA in its first year of installation and addition 10 KVA for subsequent two years .Calculate the energy loss for third year with following parameters given [8]

| | |
|---|---|
| Voltage level = 11/0.4 KV | No load losses = 200W |
| Frequency = 50 HZ | Copper loss = 1100W |
| Load Factor = 0.8 | Loss of load factor = $0.3*LF + 0.7*(LF)^2$ |

   b) Derive an expression for voltage drop and power loss over a distribution feeder assuming Uniformly Distributed Loads. [8]

***

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2079 Jestha**

| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

## *Subject:* - Transmission and Distribution system Design (*EE754*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) "In the early 90s, HVDC was the best option but now HVAC with FACTS is becoming popular". Justify the statement. [4]

   b) What are the advantages of grid/ interconnected system? [4]

   c) Select the most economical and technically adequate voltages level and a number of circuits for a transmission line to transmit 200 MW of power over 80 km. Assume pf as 0.95. [8]

| Line Length (km) | MF limit |
|---|---|
| 80 | 2.75 |
| 160 | 2.25 |
| 240 | 1.75 |
| 320 | 1.35 |
| 480 | 1 |
| 640 | 0.75 |

2. a) For a 220 kV double circuit transmission line, suggest the dimensions for following: [8]

   i) Cross arm length
   ii) Insulator string length
   iii) Horizontal and vertical separation of conductors
   iv) Number of earth wires
   v) Height of earth wire from the top most conductors.

   Take max. Swing of insulator as: 45°

   b) Explain the cause of the failure of the insulator and the method to check failure. [4]

   c) Explain voltage distribution across string insulators and discuss the selection of m to increase string efficiency. [4]

3. a) Explain Kelvin's Law for the most economical conductor size selection. [4]

   b) What is corona phenomenon in high voltage transmission system? How can we reduce corona? [4]

   c) The design data for a double circuit transmission line with a double earth wire are as follows: [8]

   Where, heights of lower, middle and top are power conductor from ground and is the total height of the tower. The power conductor has maximum working tension of 6000 kg and diameter of 4 cm. The earth wire has maximum working tension of 2000 kg and diameter of 2 cm. Assume maximum conductor deviation of 5° is permissible for all towers and wind force is /. Compute most economical span.

| Span | $D_{max}$ (m) | $h_1$ (m) | $h_2$ (m) | $h_3$ (m) | $H_t$ (m) |
|---|---|---|---|---|---|
| 250 m | 5.27 | 12.18 | 15.00 | 17.82 | 28.44 |
| 300 m | 7.30 | 14.21 | 17.03 | 19.85 | 30.47 |
| 350 m | 9.65 | 16.56 | 19.38 | 22.20 | 32.82 |

4. a) In Kathmandu, NEA is replacing the overhead distribution system with an underground system, what could be the probable technical issue and how can they be tackled?

   b) Compare between American Distribution System and the European Distribution System with necessary diagram. [6]

   c) Define load Centre. What are the points to be considered to select a suitable load center? [4]

5. a) A distribution transformer of 25 kVA with No-load loss of 72 W and Rated Cupper Loss is 300 W. Considered the demand for the transformer is 20 kW and the monthly energy sell equals 4320 units @ 0.9 power factors. Use Loss of Load Factor ( ) = 0.3 + 0.7. Find percentage energy loss. [6]

   b) What are the purposes of electric load forecasting? Describe based on time horizon considered for forecasting. [6]

   c) Define Diversity Factor. Explain its relation with number of consumers. [4]

***

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2079 Shrawan**

| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design (*EE 754*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

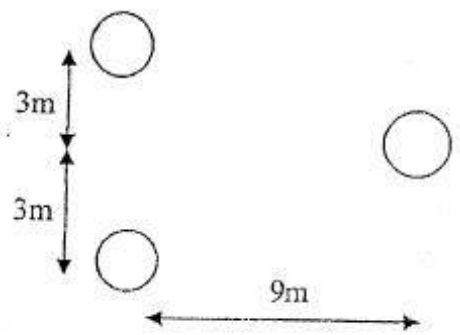
1. a) Lightning over voltage is dominating in high voltage system. [1+3]
   b) Choice of bundle conductor is to improve the voltage regulation. [1+3]
   c) For same operating voltage, lossless and loss line have same switching overvoltage. [1+3]
   d) Percentage power loss of distribution system is less in comparision with transmission system. [1+3]
2. a) How does the voltage level selection affect power loss, energy loss, and conductor and insulator economy? [8]
   b) What is the main basis for air clearance calculation in a transmission system and why? Calculate different air clearances required for Dhalkebar-Muzzafarpur line designed to operate at 220 kV double circuit. [8]
3. a) Derive expression for the actual length of conductor in the span length of a transmission line. [6]
   b) What do you mean by most economical span? For the design of most economical span of a EHV line, following information is available. [2+10]

| Span length (m) | Maximum sag (m) |
|---|---|
| 250 | 3.001 |
| 275 | 3.620 |
| 300 | 4.296 |
| 325 | 5.031 |
| 350 | 5.824 |

Technically viable conductor: Sheep

Assumption: All the towers are straight line towers, wind pressure = 100 kg/m$^2$

The air clearance is as shown in the figure, and minimum ground clearance is 10 m. Neglect the effect of ground wire.

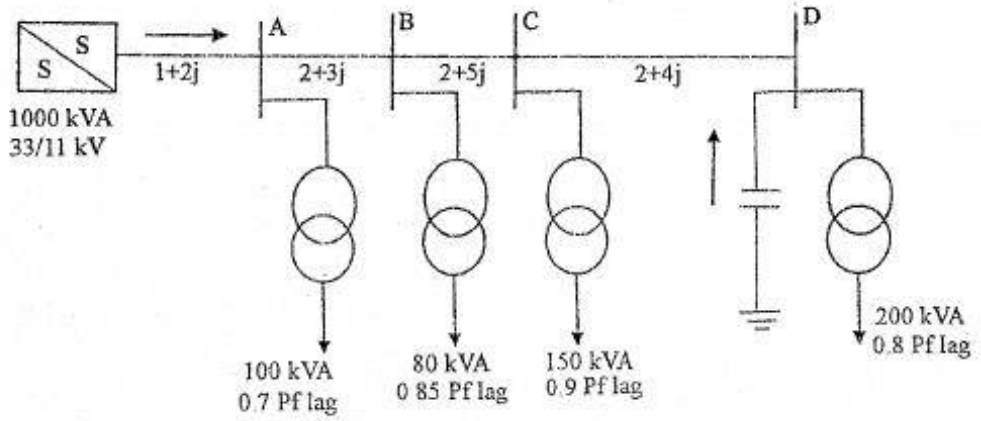


4. a) Show that the percentage voltage regulation in a primary distribution feeder is inversely proportional to the square of the line voltage. [6]

   b) Derive expression for voltage drop and power loss over distribution feeder assume load is uniformly varying. [8]

5. a) List and explain the considerations to be made while selecting distribution transformers, their location, primary and secondary voltage levels and layout. [6]

   b) For the 11 kV primary distribution network shown below, determine the size (kVAR) of the capacitor to be placed at the location shown in diagram to achieve maximum loss reduction. For simplifying the analysis. Assume voltage at each node is 1 p.u. All impedance are in p.u. at 1000 kVA. [10]




***

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2078 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE 754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary table is attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. State and justify whether the following statement are TRUE or FALSE. [(1+3)×4]
   a) Temporary overvoltage is more dominating than transient overvoltage in transmission line.
   b) Vertical configuration is generally adopted for transmission line of above 400 kV.
   c) Though thermal limit design for distribution feeder is applicable in highly dense urban areas, but the power loss are more in rural areas.
   d) For small area load forecasting, simulation method is more suitable.

2. a) What are the advantages and disadvantages of interconnected system? Discuss the need of transmission system planning. [4+4]
   b) What would be the most suitable voltage level and circuit condition for transmitting 220 MW power at power factor of 0.9 over a distance of 175 km? [6]

3. a) State and Prove Kelvin's law of most economical conductor size and explain its limitation. [8]
   b) Calculate most economical span for 180 km long single circuit transmission system with single earth wire chosen, considering the following design step data. [10]

| Span (m) | $D_{max}$ (m) | $H_1$ (m) | $H_2$ (m) | $H_3$ (m) | $H_t$ (m) |
|---|---|---|---|---|---|
| 250 | 3.15 | 10.22 | 13.60 | 16.98 | 28.84 |
| 300 | 4.32 | 11.40 | 14.72 | 18.04 | 29.98 |
| 350 | 5.48 | 12.58 | 15.95 | 19.32 | 31.22 |

Where, $H_1$: height of lower conductor from ground
$H_2$: height of middle conductor from ground
$H_3$: height of top conductor from ground
$H_t$: Total height of tower

The power conductor has maximum working tension of 6860 kg and diameter of 25.2 mm. The earth wire has maximum working tension of 2840 kg and diameter of 16.4 mm. Assume the towers consisted to be 80% type A, and other remaining are of type B in the system and the wind force of 100 kg/m$^2$.

4. a) What kind of distribution system is implemented in INPS? Explain its suitability based on the types of distribution systems you studied. [2+6]
   b) A particular load center has a peak demand of 40 kW at pf of 0.85 lagging. The distribution transformer having 200 watt iron loss and 480 watt copper loss is used to supply four 3 phase LT feeders at 380 V of equal length of 1.5 km each. If LT feeder conductor has resistance and reactance of 0.9 ohm per km and 0.25 determine
   (i) % Distribution loss
   (ii) % voltage drop in LT line [10]

5. a) What are the different methods of load forecasting? Describe briefly. [8]

   b) Describe the general criterion that should be taken in to consideration for distributor route selection. [6]

***

Table A1: Transmission line capability curve with assumption of single circuit transmission with surge impedance of 400 ohm.

| Length (km) | m.f. (limits) |
|---|---|
| 80 | 2.75 |
| 160 | 2.25 |
| 240 | 1.75 |
| 320 | 1.35 |
| 480 | 1.0 |
| 640 | 0.75 |

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2078 Kartik**

| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE 754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ ***Necessary table is attached herewith it.***

1. State whether the following statement is TRUE or FALSE. Justify your answer with a brief explanation. [4×4]
   (i) Series compensation may be used in EHV transmission line to increase the power handling capacity of the line.
   (ii) The value of SSR should not be chosen below 1.8.
   (iii)For determination of tower strength, minimum wind speed is taken into account.
   (iv)Radial distribution system is more reliable than Network system.

2. a) Discuss the steps while choosing the most economical voltage and number of circuit for a transmission line design. [10]
   b) Compare the properties of porcelain and annealed tough glass. [6]

3. For 3 phase 50 Hz transmission line to deliver 100MW of power over 70km, 132kV single circuit line has been decided to design. Suggest the suitable conductor which meets following technical criterion. [16]
   (i) Satisfy the thermal limit.
   (ii) Efficiency of line not to be less than 94%
   (iii)Voltage regulation of line not to be greater than 12%
   Use conductor table attached. Assume the ambient temperature and maximum allowable temperature same as mentioned in conductor table.

4. a) Determine the position of maximum sag from either supporting towers of equal height at a different elevation from a common reference. Also, explain the condition of virtual sag. [6]
   b) From the initial survey of particular load center, the following data has been obtained. [10]

| Consumer Class | Potential Consumer | Avg. Monthly Consumption | No. of effective days/month | 5th year load pattern | |
|---|---|---|---|---|---|
| | | | | Contribution factor to peak | Load factor |
| Domestic | 100 | 30kWh | 30 | 10 | 0.25 |
| Commercial | 20 | 30kWh | 25 | 0.5 | 0.30 |
| Non-commercial | 50 | 20kWh | 20 | 0.1 | 0.25 |

   Assuming consumption growth factor of 5% in each year for each class and electrification coverage factor by 5th year is 70% for all, determine 5th year peak load of the load center in kW.

5. a) Discuss the suitability and choice of American and European distribution system layout in context in Nepal. [6]
   b) Discuss merits and demerits of ABC (aerial bundled conductor) in LT distribution system. [4]
   c) Discuss the suitability of underground and overhead distribution system. [6]

***

| Code Name | No./Nominal diameter of wires | | Approximate Overall Diameter | Sectional Area | | | Approximate Weight | Nominal Breaking Load | Nominal DC Resistance at 20° C | Current Rating (*) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Aluminium | Steel | | Aluminium | Steel | Total | | | | |
| | No./mm | No./mm | mm | $mm^2$ | $mm^2$ | $mm^2$ | kg/km | KN | ohm/km | A |
| Mole | 6/1.50 | 1/1.50 | 4.50 | 10.6 | 1.77 | 12.4 | 42.8 | 4.14 | 2.7027 | 66 |
| Squirrel | 6/2.11 | 1/2.11 | 6.33 | 21.0 | 3.50 | 24.5 | 84.7 | 7.87 | 1.3659 | 101 |
| Fox | 6/2.79 | 1/2.79 | 8.37 | 36.7 | 6.11 | 42.8 | 148.1 | 13.21 | 0.7812 | 142 |
| Mink | 6/3.66 | 1/3.66 | 10.98 | 63.1 | 10.50 | 73.6 | 254.9 | 21.67 | 0.4540 | 199 |
| Skunk | 12/2.59 | 7/2.59 | 12.95 | 63.2 | 36.90 | 100.1 | 463.0 | 52.79 | 0.4568 | 206 |
| Beaver | 6/3.99 | 1/3.99 | 11.97 | 75.0 | 12.50 | 87.5 | 302.9 | 25.76 | 0.3820 | 221 |
| Racoon | 6/4.09 | 1/4.09 | 12.27 | 78.8 | 13.10 | 91.9 | 318.3 | 27.06 | 0.3635 | 228 |
| Otter | 6/4.22 | 1/4.22 | 12.66 | 83.9 | 14.00 | 97.9 | 338.8 | 28.81 | 0.3415 | 237 |
| Cat | 6/4.50 | 1/4.50 | 13.50 | 95.4 | 15.90 | 111.3 | 385.3 | 32.76 | 0.3003 | 256 |
| Hare | 6/4.72 | 1/4.72 | 14.16 | 105.0 | 17.50 | 122.5 | 423.8 | 36.04 | 0.2730 | 271 |
| Coyote | 26/2.54 | 7/1.91 | 15.89 | 131.7 | 20.10 | 151.8 | 520.7 | 45.86 | 0.2192 | 311 |
| Cougar | 18/3.05 | 1/3.05 | 15.25 | 131.5 | 7.31 | 138.8 | 418.8 | 29.74 | 0.2188 | 308 |
| Tiger | 30/2.36 | 7/2.36 | 16.52 | 131.2 | 30.60 | 161.8 | 602.2 | 57.87 | 0.2202 | 313 |
| Lion | 30/3.18 | 7/3.18 | 22.26 | 238.3 | 55.60 | 293.9 | 1093.4 | 100.47 | 0.1213 | 450 |
| Bear | 30/3.35 | 7/3.35 | 23.45 | 264.4 | 61.70 | 326.1 | 1213.4 | 111.50 | 0.1093 | 480 |
| Goat | 30/3.71 | 7/3.71 | 25.97 | 324.3 | 75.70 | 400.0 | 1488.2 | 135.13 | 0.0891 | 543 |
| Sheep | 30/3.99 | 7/3.99 | 27.93 | 375.1 | 87.50 | 462.6 | 1721.3 | 156.30 | 0.0771 | 592 |
| Antelope | 54/2.97 | 7/2.97 | 26.73 | 374.1 | 48.50 | 422.6 | 1413.8 | 118.88 | 0.0773 | 586 |
| Bison | 54/3.00 | 7/3.00 | 27.00 | 381.7 | 49.50 | 431.2 | 1442.5 | 121.30 | 0.0758 | 593 |
| Deer | 30/4.27 | 7/4.27 | 29.89 | 429.6 | 100.20 | 529.8 | 1971.4 | 179.00 | 0.0673 | 643 |
| Elk | 30/4.50 | 7/4.50 | 31.50 | 477.1 | 111.30 | 588.4 | 2189.5 | 198.80 | 0.0606 | 684 |
| Camel | 54/3.35 | 7/3.35 | 30.15 | 476.0 | 61.70 | 537.7 | 1798.8 | 146.40 | 0.0608 | 677 |
| Moose | 54/3.53 | 7/3.53 | 31.77 | 528.5 | 68.50 | 597.0 | 1997.3 | 159.92 | 0.0547 | 720 |

(*) Note: The values of current rating mentioned in above Table are based on wind velocity of 0.6 metre/second, solar heat radiation of 1200 watt/metre$^2$, ambient temperature of 50° C & conductor temperature of 80° C.

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2077 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE 754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

1. State and justify whether the following statement are TRUE or FALSE. [4×4]
   a) For conductor ampacity computation, maximum wind speed is taken into account.
   b) Height of tower is the function of voltage only.
   c) Corona is more dominating design criterion for LV Transmission lines.
   d) The loop arrangement of distribution feeder in urban area is relatively economical than rural area.
2. a) Discuss the criterion for single and double earth wire selection for a high voltage overhead transmission line. [6]
   b) Discuss the role of system (Neutral) earthing in the selection of overhead line insulation level. [10]
3. To transmit a given amount of power to a given distance a double circuit line with a double earth wire is choose for which the following design steps are completed, compute the most economical span. [16]

| Span | $D_{max}$ (m) | $h_1$ (m) | $h_2$ (m) | $h_3$ (m) | $H_t$ (m) |
|---|---|---|---|---|---|
| 250 m | 3.48 | 9.70 | 14.52 | 19.35 | 24.84 |
| 300 m | 5.09 | 11.30 | 16.13 | 20.96 | 26.45 |
| 350 m | 7.02 | 13.24 | 18.06 | 22.89 | 28.39 |

where $h_1$, $h_2$ and $h_3$ are height of lower, middle and top power conductor from ground and Ht is total height of tower.

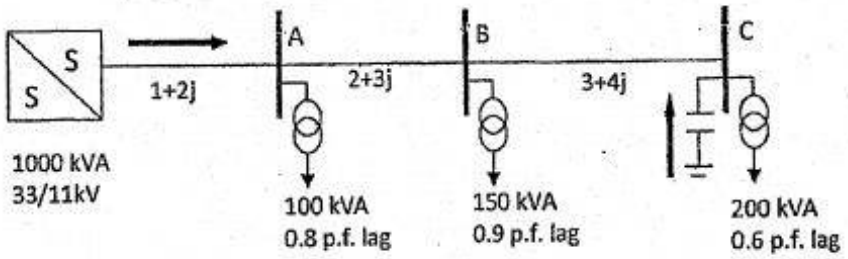
The power conductor has maximum working tension of 6890 kg and diameter of 25.97 mm. The earth wire has maximum working tension of 3332 kg and diameter of 14.60 mm. Assume maximum conductor deviation of 5° is permissible for all towers and the wind force is 100 kg/m$^2$.

4. a) Justify that there is a most economical voltage choice for a given amount of power to be transmitted over given distance. [8]
   b) Compare the merits and demerits of radial, loop and network distribution system. [8]
5. a) From the initial survey of particular load center, the following consumer data has been obtained: [10]

| Consumer Class | Potential consumer | Avg. Monthly Consumption | No. of effective days /month | 5th year load pattern | |
|---|---|---|---|---|---|
| | | | | Contribution factor to peak | Load factor |
| Domestic | 100 | 30 kWh | 30 | 1.0 | 0.25 |
| Commercial | 20 | 30 kWh | 25 | 0.5 | 0.30 |
| Non commercial | 50 | 20 kWh | 20 | 0.1 | 0.25 |

Assuming population growth factor of 1.8%, consumption growth factors of 5% in each year for each class and electrification coverage factor by 5th year is 70% for all consumers classes, determine 5th year peak load of the load center in kW. Also, Project implementation period be 2 years.

b) For the 11 kV Primary distribution Network shown below, determine the size (kVAR) of the capacitor to be placed at the location shown in diagram to achieve maximum loss reduction. For simplicity of analysis assume voltage at each node is 1 p.u. All impedances are in p.u. at 1000 kVA. [6]




***

14 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2075 Bhadra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

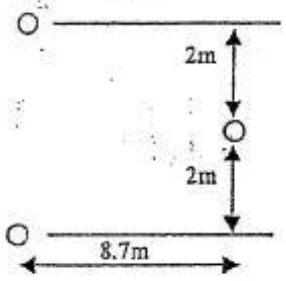
***Subject:*** - Transmission and Distribution System Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ ***<u>Conductor Table and Appendix attached herewith.</u>***
- ✓ *Assume suitable data if necessary.*

1. State the following statements are TRUE or FALSE? Justify your answer with a brief explanation. [(1+3)×4]
   a) Impulse withstand voltage of an overhead transmission line insulator depends on system (Neutral) earthing condition.
   b) Height of tower is the function of voltage only.
   c) Thermal limit design for distribution feeder is applicable in dense urban areas but power losses and voltage drop is major concern in rural areas.
   d) The peak demand of a load centre is the sum of the peak demand of different consumer classes.
2. In design of a transmission line for delivering power of 180 MW for a distance of 200 km. Considering that the system is to be operated at power factor of 0.85, find the required numbers of insulator disc per string to be selected. [16]
3. a) For the design of most economical span of a high voltage transmission line, following data are available for a particular conductor. Select the most economical span. [10]

   Given that: conductor diameter = 28 mm
   Cross sectional area = 463 $mm^2$
   UTS = 15910 kg
   Wind Pressure = 100 $kg/m^2$
   Factory of safety = 2

| Span(m) | Maximum Sag(m) |
|---|---|
| 250 | 3.24 |
| 275 | 3.88 |
| 300 | 4.57 |
| 325 | 5.32 |
| 350 | 6.12 |




   Assume: All towers are straight line towers. The air clearance is shown in figure. Minimum ground clearance is 6m. Neglect the effect of ground wire.

   b) What do you mean by corona? Derive the expression for corona inception voltage. [6]

4. a) With the help of a suitable load curve, show that loss of load factor may be expressed as;
$LLF = K_1*LF + K_2*LF^2$ [6]

b) The initial survey of a particular load center, the following consumer data has been obtained.

| Consumer Class | Potential Consumer Number | Avg. Monthly consumption (KWH) | No. of effective day/month | 5th year load Pattern | |
|---|---|---|---|---|---|
| | | | | Responsibility factor | Load factor |
| Domestic | 100 | 30 | 30 | 1.0 | 0.25 |
| Commercial | 20 | 30 | 25 | 0.5 | 0.3 |
| Non-commercial | 50 | 20 | 20 | 0.1 | 0.25 |

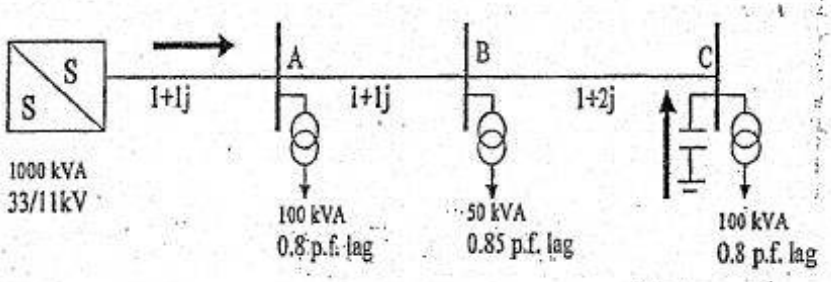
Assuming consumption growth factor of 5% in each year for each class and electrification coverage factor by 5th year is 70% for all consumer classes. Determine 5th year peak load of the load center in KW. (Neglect project implementation period) [10]

5. a) A particular load center has a peak demand of 50 kW at power factor of 0.8 lagging. Compute % peak power loss and voltage drop in 3 phase LT feeder configuration with rated transformer of 11/0.4 kV.

| Option | Feeder configuration |
|---|---|
| I | 4 feeders each of length 3km |
| II | 2 feeders each of 4 km |
| III | 3 feeders each of 2 km |

Impedance per phase = (1.1+0.25) Ω/km. Assume uniformly distributed load along feeders [10]

b) For the 11 kV Primary distribution Network shown below, determine the size (kVAR) of the capacitor to be placed at the location shown in diagram to achieve the maximum loss reduction. For simplifying the analysis assume voltage at each node is 1 p.u. All impedances are in p.u. at 1000 kVA. [6]




***

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2074 Bhadra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

## *Subject:* - Transmission and Distribution System Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. State and justify whether the following statements are true or false. [(1+3)*4]
   a) Interconnected system decreases SCMVA of the connected bus.
   b) The effective way to increase corona inception voltage is to increase the conductor size.
   c) The value of SSR should not be chosen below 1.8.
   d) For design of urban distribution line first select the transformer location and then size of the conductor.

2. a) Discuss the economical and technical criterion to be considered while selecting the best suitable standard voltage level and number of circuits for transmission line design. [8]

   b) For a double circuit, 132 kV transmission line, find the following air clearance with justifications. [8]
      i) Cross arm length
      ii) Insulator string length
      iii) Horizontal and Vertical separation of conductor
      iv) Height of earth wire from top most conductor.

3. a) Determine the horizontal position of maximum sag from either supporting towers of equal height at a different elevation from a common reference. Also, explain the condition of virtual sag. [6]

   b) Explain the different types of insulator failure. [4]

4. a) To transmit the given amount of power to a given distance a single circuit with single earth wire is chosen for which the following design steps are completed; compute the most economical span if the transmission length is 200 km. [12]

| span(m) | Dmax(m) | H1(m) | H2(m) | H3(m) | Ht(m) |
|---|---|---|---|---|---|
| 250 | 3.14 | 10.245 | 13.555 | 16.865 | 28.815 |
| 275 | 3.69 | 10.801 | 14.111 | 17.421 | 29.371 |
| 300 | 4.27 | 11.383 | 14.693 | 18.003 | 29.953 |
| 325 | 4.88 | 11.965 | 15.298 | 18.608 | 30.558 |
| 350 | 5.50 | 12.548 | 15.923 | 19.233 | 31.183 |

Where H1 height of lower conductor from ground
H2 height of middle conductor from ground
H3 height of top conductor from ground
Ht total height of tower.

The power conductor has maximum working tension of 6890 kg and diameter of 25.97mm. The earth wire has maximum working tension of 2856 kg and diameter of 16.52mm. Assume 80% tower are of A type. 15% are of B type and 5% are of C type and the wind force is 100 kg/m$^2$.

b) What is Ruling span? Explain the surveying requirement for transmission and distribution line design. [1+3]

5. a)Show that the voltage drop and power loss in feeder of uniformly distributed load is half and one third of that in end loaded condition. [8]

b) The consumer data for particular distribution transformer for a specified year is as shown as follows. [10]

Table-1

| Consumer class | Class A | Class B | Class C |
|---|---|---|---|
| Consumer Number | 80 | 30 | 40 |
| Monthly energy consumption | 30 kwh | 22 kwh | 25 kwh |
| No. of effective days per month | 30 | 24 | 26 |
| Coincidence factor | 1 | 0.9 | 0.95 |
| Power factor | 0.9 | 0.8 | 0.85 |
| Load pattern | Table 2 | Table 2 | Table 2 |

Table-2

| Time (hrs.) | 0.00-6.00 | 6.00-10.00 | 10.00-14.00 | 14.00-18.00 | 18.00-21.00 | 21.00-24.00 |
|---|---|---|---|---|---|---|
| Class A | 0.1 | 0.4 | 0.2 | 0.2 | 1 | 0.4 |
| Class B | 0.1 | 0.1 | 0.5 | 1 | 0.5 | 0.1 |
| Class C | 0.1 | 0.1 | 1 | 1 | 0.1 | 0.1 |

Determine the following.

For each class of consumer:

i. peak load
ii. Load factor (daily and annual)
iii. Contribution factor
iv. Annual energy sell

For distribution transformer (Neglect LT losses)

i. peak load
ii. Load factor
iii. Annual energy sells.

c) Explain the small area load forecasting with the help of load growth curve of small area. [4]

***

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
2074 Magh

| Exam. | | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. State the following statements are TRUE or FALSE? Justify your answer with a brief explanation. [(1+3)×4]
   a) Power transfer capability of a transmission line increases with increase in line length at same voltage.
   b) The insulators are designed so that it will punctured before it gets flashover.
   c) The value of Switching Surge Ratio (SSR) increasing the system voltage for insulation coordination designing purpose.
   d) The height of a tower is independent of span length of the transmission line.
2. a) Design of transmission line is to be carried out to deliver 200 MW of power over a distance of 160 km. Design. [10]
      i) Standard voltage of power transmission
      ii) Number of transmission line circuits
      iii) Number of standard disc insulators needed to withstand Lighting overvoltage

      Assume that Flashover withstand ratio = 1.15, Non-atmospheric condition factor = 1.1, Factor of safety = 1.1. Use attached Appendix for relevant data.

   b) Explain the basic configuration and advantage of string insulator used in HV line brief. [6]
3. a) To transmit given amount of power to a given distance a double circuit line with a double earth wire is chosen for which the following design steps are completed, compute the most economical span. [10]

| Span | $D_{max}$ (m) | $h_1$ (m) | $h_2$ (m) | $h_3$ (m) | $H_t$ (m) |
|---|---|---|---|---|---|
| 250 m | 3.48 | 9.70 | 14.52 | 19.35 | 24.84 |
| 300 m | 5.09 | 11.30 | 16.13 | 20.96 | 26.45 |
| 350 m | 7.02 | 13.24 | 18.06 | 22.89 | 28.39 |

where $h_1$, $h_2$, and $h_3$ are height of lower, middle and top power conductor from ground and $H_t$ is total height of tower.

The power conductor has maximum working tension of 6890 kg and diameter of 25.97mm. The earth wire has maximum working tension of 3332 kg and diameter of 14.60mm. Assume maximum conductor deviation of $5^0$ is permissible for all towers and the wind force is 100 kg/m$^2$.

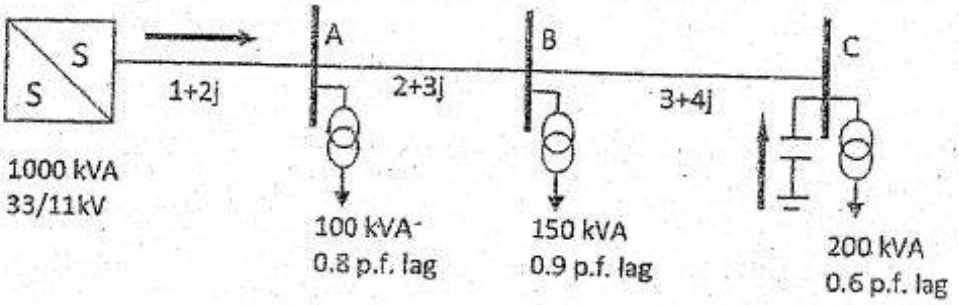
   b) Derive the expression for maximum sag when the supports are at different level from the reference line. [6]

4. a) Discuss the comparative assessments for following: [8]

   i) Overhead and underground distribution system
   ii) Radial and Loop distribution system

   b) Compute the power loss and maximum voltage drop for a 16 km long 11 KV, 3 phase primary distribution line having sending end current of 100A with uniformly varying load. (Use R = 0.6Ω/km and X = 0.3 Ω/km) [8]

5. a) For a 11 kV Primary distribution Network shown in below, determine the size (kVAR) of the capacitor to be placed at the location shown in diagram to achieve maximum loss reduction. For simplicity of analysis assume voltage at each node is 1 p.u. All impedances are in p.u. at 1000 kVA. [8]




b) Discuss the primary considerations to be given while selecting a distribution transformer size and its location. [8]

***

22 - TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2073 Bhadra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE 754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. State and justify whether the following statements are true of false. [4×4]
   a) Horizontal conductor configuration is general choice for and above 400 kV transmission line.
   b) The current carrying capacity of conductor increases with increase in ambient temperature.
   c) Corona is more dominating design criterion for LV Transmission lines.
   d) Network distribution system is more reliable than Radial Distribution system.
2. a) Explain the effect of varying following parameter on conductor and insulator cost per unit length of transmission line. [8]
   (i) Power to be transmitted and length of line
   (ii) Voltage level
   (iii)Number of circuit
   b) Compute the various air clearances required for a 220 kV single circuit Transmission line. [8]
3. a) Explain the factors affecting the choice of BIL of a transmission line for insulator discs selections. [6]
   b) To transmit the given amount of power to a given distance a single circuit with single earth wire is chosen for which the following design steps are completed, compute the most economical span if the transmission length is 200 km. Assume 10% of Towers have been used to take care of maximum angle deviation of 15° and rest are straight line Towers.

| Span (m) | Dmax(m) | H1(m) | H2(m) | H3(m) | Ht(m) |
|---|---|---|---|---|---|
| 250 | 3.14 | 10.245 | 13.555 | 16.865 | 28.815 |
| 275 | 3.69 | 10.801 | 14.111 | 17.421 | 29.371 |
| 300 | 4.27 | 11.383 | 14.693 | 18.003 | 29.953 |
| 325 | 4.88 | 11.965 | 15.298 | 18.608 | 30.558 |
| 350 | 5.50 | 12.548 | 15.923 | 19.233 | 31.183 |

where,

$H_1$ height of lower conductor from ground
$H_2$ height of middle conductor from ground
$H_3$ height of top conductor from ground
$H_t$ total height of tower

The power conductor has UTS of 8000 kg and diameter of 20 mm. The earth wire has maximum working tension of 4000 kg and diameter of 16 mm.
Wind Force: 80 kg/m$^2$ and Factor of safety for Tension is 2. [10]

4. a) Explain the dependency of energy loss computation in a transmission / distribution line on the load factor with proper mathematical aid. [8]

   b) Show that the percentage voltage Regulation in a Primary distribution feeder is inversely proportional to the square of the line voltage. [8]

5. a) Explain one of the small area forecasting method. [6]

   b) A 11 kr /0.4 kv, 100 KVA distribution transfomer has 4 outgoing secondary distribution lines of 1.5 km each. The conductor used has resistance of 1Ω / km. Determine the monthly energy loss in the lines if the peak demand of the load centre has 80 KVA at the load factor of 0.4. Given LLF = 0.3LF + 0.7 LF$^2$. [10]

***

P.T.O.

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2073 Magh**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

## *Subject:* - Transmission and Distribution System Design *(EE 754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. State whether the following statements are TRUE or FALSE? Justify your answers with a brief explanation. [(1+3)×4]
   a) Most economical voltage increases with increase in number of circuits.
   b) Corona Inception voltage is inversely proportional to the GMR of conductor.
   c) Maximum sag in stringing condition is greater than in toughest and easiest conditions.
   d) For design of rural distribution first select the transformer size and then size of the load centre.

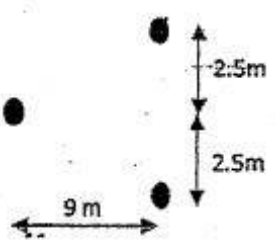
2. a) Discuss and Explain the Appropriateness of Emperical Formula used for most Economical Voltage Selection based on number of circuit to transmit P MW power over a distance of L km given in Appendix. Hence choose the most suitable standard voltage and number of circuit for 150 MW power over a distance of 100 km. [4+6]

   b) Discuss the various factors affecting the air clearance for a transmission line of a given voltage. [6]

3. a) Discuss the role of system neutral earthing in insulation level selection for a transmission line. [6]

   b) For a 3-phase 50Hz transmission line to deliver 100 MW of power over 80 km, 132 kV single circuit line with following air clearances of phase conductors has been decided to design. Suggest the best suitable conductor which meets following technical criterion: [10]

   (i) Satisfy the thermal limit
   (ii) Efficiency of line not to be less than 94%
   (iii)No Corona in fair weather condition




4. a) Explain the factors affecting the tower cost for transmission line. Derive the expression for computing the bending moment acting on tower due to turning of line by an angle of α. [6]

b) The consumer data for particular distribution transformer for a specified year is as shown as follows. [10]

Table - 1

| Consumer class | Class A | Class B | Class C |
|---|---|---|---|
| Consumer Number | 80 | 30 | 40 |
| Monthly energy consumption | 30 kwh | 22 kwh | 25 kwh |
| No. of effective days per month | 30 | 24 | 26 |
| Coincidence factor | 1 | 0.9 | 0.95 |
| Power factor | 0.9 | 0.8 | 0.85 |
| Load pattern | Table 2 | Table 2 | Table 2 |

Table - 2

| Time(hrs.) | 0.00-6.00 | 6.00-10.00 | 10.00-14.00 | 14.00-18.00 | 18.00-21.00 | 21.00-24.00 |
|---|---|---|---|---|---|---|
| Class A | 0.1 | 0.4 | 0.2 | 0.2 | 1 | 0.4 |
| Class B | 0.1 | 0.1 | 0.5 | 1 | 0.5 | 0.1 |
| Class C | 0.1 | 0.1 | 1 | 1 | 0.1 | 0.1 |

Determine the Peak demand if the load center.

5. a) Explain the suitability of single phase and 3-phase distribution transformer. [6]

b) A 11kV/0.4kV, 50 kVA distribution transformer has No-load loss of 120W and Rated copper loss of 200W. Determine the percentage monthly energy loss of the transformer if the peak demand is 30 kVA at a Power factor of 0.9 and load factor of 0.3. Given $LLF = 0.3LF+0.7LF^2$. [10]

***

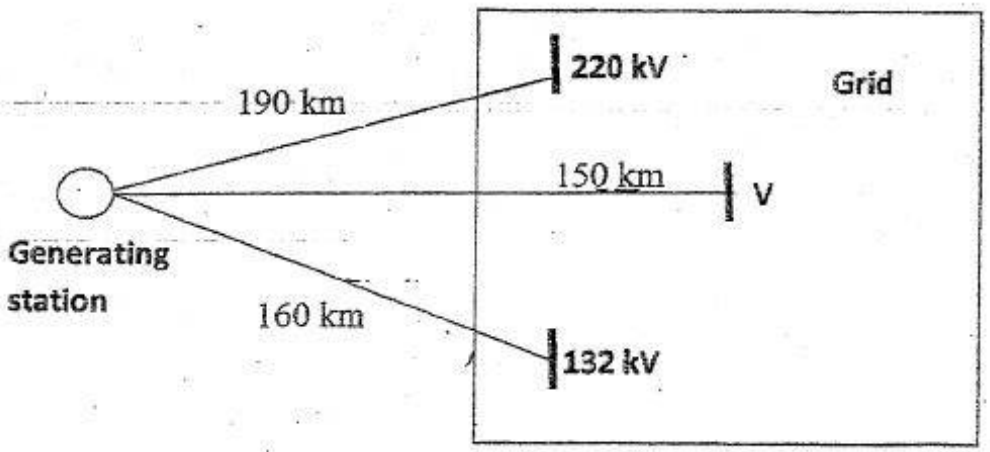
22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2072 Ashwin**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. State whether the following statements are TRUE or FALSE. Justify your answer with a brief explanation. [3×4]
   i) Loss of load factor (LLF) is always unity while evaluating energy loss from constant power loss.
   ii) ACSR is preferred choice than AAAC (All Aluminum alloyed conductor) for transmission line because of its high tensile strength.
   iii) The value of SSR is kept larger as the system voltage is higher over 220kV.
   iv) The X/R ratio is high for transmission line while low for distribution lines.
2. a) Make a detail technical and economic comparison of ac & dc transmission. [8]
   b) Describe the steps to be followed while selecting the number of insulator discs for a transmission line design. [8]
3. a) A transmission line is to be designed for interconnecting a generation of 250MW power to the power system grid. The scenario of generating site and vicinity of grid is depicted in the figure below. Suppose you are appointed as an electrical engineer to design the voltage level and number of circuit for above power transmission, what would be your selection among the options? Justify your selection. [10]




   b) Compute ratio of vertical separation of conductors of 132 kV and 220 kV double circuit transmission line. Derive any expressions used. [8]

4. To transmit a given amount of power to a given distance, double circuit line with a double earth wire is chosen for which the following design step are completed, compute the most economical span. [15]

| Span (m) | $D_{max}$ | $H_1$(m) | $H_2$(m) | $H_3$(m) | Ht(m) |
|---|---|---|---|---|---|
| 250 | 5.27 | 12.178 | 14 998 | 17.818 | 28.444 |
| 275 | 6.24 | 13.148 | 15.968 | 18.788 | 29.414 |
| 300 | 7.3 | 14.208 | 17.028 | 19.848 | 30.474 |
| 325 | 8.43 | 15.338 | 18.158 | 20.978 | 31.604 |
| 350 | 9.65 | 16.558 | 19.378 | 22.198 | 32.824 |

Where, $H_1 \rightarrow$ Height of lower condition from ground, $H_2 \rightarrow$ Height of middle condition from ground, $H_3 \rightarrow$ Height of top condition from ground, Ht $\rightarrow$ total height. The power conductor has maximum working tension of 6000 kg and diameter of 4 cm. The earth wire has maximum tension of 2000 kg and diameter of 2 cm. Assume 80% as tower A, 15% as tower B and 5% tower C and the wind force is 100 kg/m$^2$.

5. a) A particular load center has a peak demand of 50 kW at a power factor of 0.8 lagging. For the following two cases of 3 phase LT feeder configuration at distribution transformer, compute the % peak power loss and maximum percentage voltage drop in LT. [10]

Option I : 4 feeders each of length 2 km

Option II : 2 feeders each of length 4 km

The resistance and reactance per phase of LT conductors are 1.1 Ω/km and 0.25 Ω/km. Assume uniformly distributed load along the feeders. The distribution transformer is rated 11/0.4 kv

b) From the initial survey of a particular load center, the following consumer data has been obtained: [9]

| Consumer class | Potential Consumer | Avg. monthly Consumptino | No. of Effective Days/month | 5th Year load pattern | |
|---|---|---|---|---|---|
| | | | | Contribution Factor to Peak | Load Factor |
| Domestic | 100 | 30 KWh | 30 | 1.0 | 0.25 |
| Commercial | 20 | 30 KWh | 30 | 0.5 | 0.30 |
| Non-Commercial | 50 | 20 KWh | 20 | 0.1 | 0.25 |

Determine the 5th year peak load of load center in kW.

**Data for load forecast(for all consumer classes):**

Load growth factor: 5% for first year and an increment of 1% from 2nd year.

Population growth factor: 2% each year.

Percentage coverage factor: 70% by 5th year.

***

21 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2072 Magh**

| Exam. | New Back & Later Batch | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) State whether the following statements are TRUE OR FALSE? Justify your answers with a brief explanation. [3×4]
   i) Interconnected system reduces the fault MVA of the connected bus.
   ii) HVDC converter station requires huge amount of reactive power support.
   iii) For a 765 KV line transient stability limit is more than the thermal limit.
   iv) Height of the tower is independent of span of line.

   b) Justify the following statements in brief: [4]
   i) The underground distribution feeder mayn't only be a necessity but also economical in urban area.
   ii) The trending method of the load forecast is more suitable for large area load forecast

2. a) Select the most economical and technically adequate voltage level and no-of circuit for a transmission line to transmit 160 MW at a distance of 100 Km. [8]

   b) Discuss the primary considerations to be given when selecting a load center and distribution transformer while designing a grid extended rural and urban distribution. [6]

3. a) Why is it necessary to compute the tension in conductor for transmission line under varying condition? Derive the equation correlating the tension in line in two different conditions. [2+8]

   b) Discuss the suitability and choice of American and European distribution system layout in context of Nepal. [6]

4. a) The design data for a double circuit transmission line with a double earth wire are as follows: [10]

| Span | $D_{max}$ (m) | $h_1$ (m) | $h_2$ (m) | $h_3$ (m) | $H_t$ (m) |
|---|---|---|---|---|---|
| 250 m | 5.27 | 12.18 | 15.00 | 17.82 | 28.44 |
| 300 m | 7.30 | 14.21 | 17.03 | 19.85 | 30.47 |
| 350 m | 9.65 | 16.56 | 19.38 | 22.20 | 32.82 |

where $h_1$, $h_2$, and $h_3$ are heights of lower, middle and top power conductor from ground and $H_t$ is the total height of tower.

The power conductor has maximum working tension of 6000 kg and diameter of 4 cm. The earth wire has maximum working tension of 2000 kg and diameter of 2 cm. Assume maximum conductor deviation of $5^0$ is permissible for all towers and the wind force is 100 kg/m$^2$.

Compute the most economical span.

   b) Classify the overhead line insulators. Write advantages of string insulators for HV lines and state the various configuration of string insulator. [6]

5. A particular load center with uniformly distributed load of peak demand 40 KW has a power factor of 0.8. The distribution transformer has four 3ϕ LT feeders at 380 V of equal length of 2 km each. If the per phase resistance and reactance of LT conditions are 1.1Ω/ km and 0.25Ω/km, determine: [10]

   i) LT percentage peak power 1011
   ii) Maximum percentage voltage drop in LT

6. Design of a transmission line is carried out to deliver 250 MW of power over a distance of 160 km. Design [8]

   a) Standard voltage of power transmission
   b) Number of transmission line circuits
   c) Number of disc insulators needed to withstand Lightning overvoltage

   Assume that Flashover withstand ratio = 1.15, Non-atmospheric condition factor = 1.1, Factor of safety = 1.1. Use attached Appendix for relevant data.

***

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2071 Bhadra**

| Exam. | Regular / Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ ***<u>Necessary tables are attached herewith.</u>***
- ✓ *Assume suitable data if necessary.*

1. State whether the following statements are TRUE or FALSE? Justify your answers with a brief explanation. [(1+3)×4]
   a) Grid connected power system is more stable.
   b) The value of Switching Surge Ratio (SSR) is kept smaller as the system voltage is higher over 220 kV.
   c) For an overhead line insulator, the flash over voltage should be made greater than puncture voltage.
   d) The effective way to increase the corona inception voltage is to increase the conductor size.

2. a) Discuss the economical and technical criterion to be considered while selecting the best suitable standard voltage level and number of circuits for transmission line design. [8]
   b) For a double circuit, 220 kV transmission line, find the following air clearance with justifications. [8]
      i) Cross arm length
      ii) Insulator string length
      iii) Horizontal and vertical separation of conductor
      iv) Height of earth wire from top most conductor

3. a) Determine the horizontal position of maximum sag from either supporting towers of equal height at a different elevation from a common reference. Also, explain the condition of virtual sag. [6]
   b) For transmission line design following computations has been made. Select the most economical conductor. [10]

| Conductor | Total tower cost/km (1000 Rs.) | Total conductors cost/km (1000 Rs.) | Annual energy loss/km (1000 Rs.) |
|---|---|---|---|
| Goat | 890 | 1254 | 32 |
| Sheep | 936 | 1450 | 27 |
| Zebra | 974 | 1585 | 24 |
| Deer | 964 | 1663 | 24 |
| Elk | 968 | 1847 | 21 |

Using the following data.

Energy Rate = Rs. 7.2 per unit
Interest Rate = 10%
Project Life = 20 years

4. a) Discuss the primary considerations to be given while selecting a distribution transformer size and its location. [6]

b) Using equation $LLF = K_1*LF+K_2*LF^2$, compute the appropriate value of $K_1$ and $K_2$ of system having following load pattern. [10]

| Time (hrs) | 0:00 - 6:00 | 6:00 - 10:00 | 10:00 - 14:00 | 14:00 - 18:00 | 18:00 - 21:00 | 21:00 - 24:00 |
|---|---|---|---|---|---|---|
| Demand (MW) | 0 | 4 | 2 | 2 | 10 | 4 |

5. a) List out the considerations to be made while sitting an area substation. [4]

b) State and prove Kelvin's Law of most economical conductor size. Explain its limitation. [6]

c) Derive expression for voltage drop and power loss over a distribution feeder assuming uniformly varying loading. [6]

***

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
2071 Magh

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

*Subject:* - Transmission and Distribution System Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary tables/figures are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. State whether the following statements are TRUE or FALSE? Justify your answers with a brief explanation. [(1+3)*4]
   a) On increasing the voltage level, the cost of pin type insulator varies linearly.
   b) The value of SSR should not be chosen below 1.8.
   c) While designing the insulator, the flash over voltage should be made greater than puncture voltage.
   d) For the same operating voltage level, lossless line and lossy line have same switching over voltage.
2. a) Discuss the effect of voltage level in power and energy loss, and conductor and insulator economy. [10]
   b) Compare Toughend Glass Insulator and Porcelain Insulator. [6]
3. a) Determine the position of maximum sag from either supporting towers of equal height at a different elevation from a common reference. Also, explain the condition of virtual sag. [6]
   b) For transmission line design following computations has been made. Select the most economical conductor. [8]

| Conductor | Total tower cost/Km (1000Rs) | Total conductor cost/Km (1000Rs) | Annual energy loss/Km (1000 kWh) |
|---|---|---|---|
| Goat | 890 | 1254 | 32 |
| Sheep | 936 | 1450 | 27 |
| Zebra | 974 | 1585 | 24 |
| Deer | 964 | 1663 | 24 |
| Elk | 968 | 1847 | 21 |

Using the following data choose the best conductor.
Energy Rate = Rs. 9.0 per unit
Interest Rate = 10%
Project Life = 20 years

4. a) Explain the electrical considerations required to be made while selecting a conductor for a high voltage transmission line. [8]

b) Using equation $LLF = K_1*LF+K_2*LF^2$, compute the appropriate value of $K_1$ & $K_2$ of system having following load pattern. [6]

| Time (hrs.) | 0:00-6:00 | 6:00-10:00 | 10:00-14:00 | 14:00-18:00 | 18:00-21:00 | 21:00-24:00 |
|---|---|---|---|---|---|---|
| Demand (MW) | 0 | 4 | 2 | 2 | 10 | 4 |

c) Discuss merits and demerits of ABC (Aerial Bundled Conductor). [8]

5. a) Three villages A, B and C are situated at an equal distance of 0.6 km from each other and their respective loads are 20 kW, 50 kW and 30 kW. Find their Distribution Transformer location relative to the location of village A assuming yourself as an Electrical Engineer. [6]

b) Explain different factors to be taken into consideration for reducing power loss in distribution system. [6]

***

## Appendix

I. Most economical Voltage empirical formula: $5.5\left[\frac{Lt}{1.6}+\frac{P\times1000}{\cos\phi\times\lambda c\times150}\right]^{0.5}$ Lt in km and P in MW

II. Standard Voltage : 66 kV, 132 kV, 220 kV, 400 kV

III. Table-A-1 Transmission line capability curve with assumption of single circuit transmission line surge impedance of 400 Ω

| length (km) | multiplying factor* |
|---|---|
| 80 | 2.75 |
| 160 | 2.25 |
| 240 | 1.75 |
| 320 | 1.35 |
| 480 | 1.0 |
| 640 | 0.75 |

m.f.= power transmission Capability /SIL

IV. Minimum air clearance: 1cm per 1 kV(peak) and factor of safety = 25 cm

V. Table-A-2 Withstand voltage capability for different system voltages

| Maximum system Voltage | 1 Minute Dry withstand (kV) | 1 Minute Wet withstand (kV) | Impulse withstand (kV) |
|---|---|---|---|
| 123 | 215 | 185 | 450 |
| 145 | 265 | 230 | 550 |
| 255 | 435 | 395 | # 900 |
| 420 | 760 | 680 | 1550 |

VI. Table-A-3 Flashover voltages for 254 x 154 mm disc insulators

| No. of Discs | 1 Minute Dry FOV (kV) | 1 Minute Wet FOV (kV) | Impulse FOV (kV) |
|---|---|---|---|
| 1 | 80 | 50 | 150 |
| 2 | 155 | 80 | 255 |
| 3 | 215 | 130 | 355 |
| 4 | 270 | 170 | 440 |
| 5 | 325 | 210 | 525 |
| 6 | 380 | 250 | 610 |
| 7 | 435 | 290 | 695 |
| 8 | 485 | 330 | 780 |
| 9 | 535 | 370 | 860 |
| 10 | 585 | 410 | 945 |
| 11 | 635 | 450 | 1025 |
| 12 | 685 | 485 | 1105 |
| 13 | 730 | 520 | 1185 |
| 14 | 775 | 555 | 1265 |
| 15 | 820 | 590 | 1345 |
| 16 | 865 | 620 | 1425 |
| 17 | 910 | 650 | 1505 |
| 18 | 955 | 680 | 1585 |
| 19 | 1000 | 710 | 1665 |
| 20 | 1045 | 740 | 1745 |

VII. Minimum air clearance: 6.5 inch per 230kV(rms) and factor of safety = 6inch

VIII. Maximum Insulator string swing: 45°

IX. Toughest Condition: 0° C, 100kg/m² wind, no ice

X. Easiest condition; 60° no wind

XI. Stringing condition: 27°, no wind

XII. Minimum ground clearance: (V-33)/33 + 17 ft where V is L-L maximum system Voltage

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2070 Magh**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

*Subject:* - Transmission and Distribution System Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

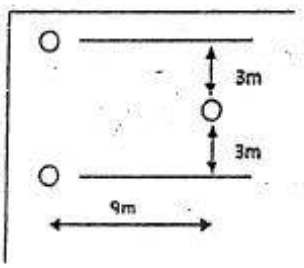
1. State whether the following statements are TRUE or FALSE? Justify your answers with a brief explanation. [(1+3)*4]
   a) The Simulation method of the load forecasting is more suitable for small area load forecast.
   b) HVDC transmission system is better choice in case of longer length than HVAC transmission system.
   c) While designing the long transmission line, if the stability criterion is met then the thermal criterion is also met.
   d) The AAAC is superior to the AAC in terms of electrical conductivity.

2. a) Explain the merits & demerits of grid connected power system. [6]
   b) Explain the dependency of power transfer limit to surge impedance ratio & length of transmission line. [4]
   c) Explain the basic configurations of insulating string in brief. [6]

3. a) Using the equation of maximum sag & conductor length directly derive the stringing equation. [6]
   b) For the design of most economical span of an extra high voltage transmission line, following data are available for a particular conductor. Select the most economical span.

Given that: conductor diameter = 21mm
conductor Cross sectional area = 262 $mm^2$
conductor UTS = 9127 kg
Wind Pressure = 100 $kg/m^2$

| Span(m) | Maximum Sag(m) |
|---|---|
| 250 | 4.36 |
| 275 | 5.22 |
| 300 | 6.04 |
| 325 | 6.89 |
| 350 | 7.81 |

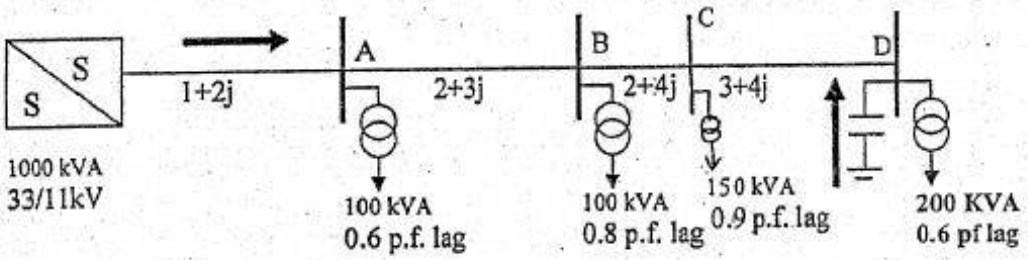



**Assume:** All towers are straight line towers. The air clearance is shown in figure. Minimum ground clearance is 10 m. Neglect the effect of ground wire. [10]

4. a) With help of arbitrary load curve derive the correlation between load factor (LF) & loss of load factor (LLF) as $LLF = K_1*LF+K_2*LF^2$. [6]

b) Compute the power loss & voltage drop for a 15 km long 11 kV three phase distribution feeder having sending end current of 100A with uniformly distributed load. Use z = (0.6+3j) Ω/ km. Derive any expression used in above calculation. [10]

5. a) For the 11 kV Primary distribution Network shown below, determine the size (kVAR) of the capacitor to be placed at the location shown in diagram to achieve the maximum loss reduction. For simplifying the analysis assume voltage at each node is 1 p.u. All impedances are in p.u. at 1000 kVA. [10]




b) Discuss merits and demerits of ABC (Aerial Bundled Conductor) in LT distribution system. [6]

***

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2070 Bhadra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL | Pass Marks | 32 |
| Year / Part | IV / II | Time | 3 hrs. |

***Subject:*** - Transmission and Distribution System Design *(EE754)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary data/tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) With clear distinction, explain the suitability of increasing the system voltage and increasing the number of circuits during the voltage selection process for a HV transmission line design. [8]

   b) Select most economical and technically adequate voltage level and number of circuits for a transmission line to transmit 300 MW of power over a distance of 200 km. [8]

2. a) For a 220 kV double circuit transmission line, suggest the dimensions for following. [8]

   i) Cross arm length
   ii) Insulator string length
   iii) Horizontal and vertical separation of conductors
   iv) Number of earth wires
   v) Height of earth wire from the top most conductor

   (Take max. swing of insulator as: 45°)

   b) Discuss the role of system earthing in the selection of overhead transmission line insulation level for temporary, lighting and switching over voltages. [8]

3. To transmit a given amount of power to a given distance a double circuit line with a double earth wire is chosen for which the following design steps are completed, compute the most economical span. [16]

| Span | $D_{max}$ (m) | $h_1$ (m) | $h_2$ (m) | $h_3$ (m) | $H_t$ (m) |
|---|---|---|---|---|---|
| 250 m | 5.27 | 12.178 | 14.998 | 17.818 | 28.444 |
| 275 m | 6.24 | 13.148 | 15.968 | 18.788 | 29.414 |
| 300 m | 7.30 | 14.208 | 17.028 | 19.848 | 30.474 |
| 325 m | 8.43 | 15.338 | 18.158 | 20.978 | 31.604 |
| 350 m | 9.65 | 16.558 | 19.378 | 22.198 | 32.824 |

Where $h_1$ height of lower conductor from ground
$h_2$ height of middle conductor from ground
$h_3$ height of top conductor from ground
$H_t$ Total height of tower

The power conductor has maximum working tension of 6000 kg and diameter of 4 cm. The earth wire has maximum working tension of 2000 kg and diameter of 2 cm. Assume maximum conductor deviation of 5° is permissible for all towers and the wind force is 100 kg/m$^2$.

4. With reference to a distribution system design, state whether the following statements are True or False with justification. [(1+3)×4]

   a) In rural distribution, its good practice to go for higher primary distribution voltage than usual.

   b) The underground distribution is relatively economical in rural distribution than urban distribution.

   c) In Nepal, the primary and secondary distribution systems operate in radial.

   d) If the utilization voltage is lower, single phase distribution transformers are preferable choice.

5. a) From the initial survey of a particular load center, the following consumer data has been obtained. [10]

| Consumer class | Potential consumer no. | Avg. monthly consumption (KWH) | No. of effective day/month | $5^{th}$ year load pattern | |
|---|---|---|---|---|---|
| | | | | Responsibility factor | Load factor |
| Domestic | 100 | 30 | 30 | 1.0 | 0.25 |
| Commercial | 20 | 30 | 25 | 0.5 | 0.3 |
| Non-commercial | 50 | 20 | 20 | 0.1 | 0.25 |

   Assuming consumption growth factors of 5% in each year for each class and electrification coverage factor by $5^{th}$ year is 70% for all consumers classes determine $5^{th}$ year peak load of the load center in KW. (Neglect project implementation period)

   b) Explain the advantages of higher value of load factor with mathematical aid. [6]

***