SASURIE COLLEGE OF ENGINEERING
Vijayamangalam, Tiruppur.

Criterion 1	Curricular Aspects	100

1.1 Curricular Planning and Implementation (20)

1.1.1The Institution ensures effective curriculum planning and delivery through a well-planned and documented process including Academic calendar and conduct of continuous internal Assessment

Table of Contents

SASURIE INSTITUTIONS

SASURIE COLLEGE OF ENGINEERING

Approved by AICTE, New Delhi
Affiliated to Anna University, Chennai

Department : EEE
Subject Code & Name : EE3401 / Transmission & Distribution
Class & Batch : II - EEE
Semester : IV

CONTENTS – COURSE FILE

S.NO	PARTICULARS	REMARKS
1	Time Table	✓
2	Student name list	✓
3	Student arrear list	
4	Subject Information Record	✓
5	Syllabus	✓
6	Lesson Plan	✓
7	Test Plan for the Subject	✓
8	Result Analysis	✓
9	Corrective Action Report	✓
10	Quality objective monitoring record	✓
11	Internal test mark sheet(Consolidated)	✓
12	Internal test question paper with answer key	✓
13	Model question paper with answer key	✓
14	Slip test question paper with answer key	✓
15	Sample Answer paper for all test(Min-3)	✓
16	Content beyond the syllabus	✓
17	Tutorial Class – schedule and content	
18	Assignment – schedule and paper	✓
19	PPT - handout	
20	Question bank	✓
21	Sample university question papers(min 5 QP-recent exam)	✓
22	Personal Log book – Updated	
23	Lecture Note	
24	Special Class if any, Approval letter, Schedule, content covered.	

	Prepared By	Approved By
Sign:	K. Vanitha (signature)	(signature)
Name:	K. VANITHA	S. MOHANRAJ
	Faculty	HoD

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SASURIE COLLEGE OF ENGINEERING

Vijayamangalam, Tiruppur

Department of Electrical and Electronics Engineering

ACADEMIC YEAR : 2023-24 SEMESTER : IV

CLASS : II EEE

HOUR	I	II		III	IV		V	VI		VII	VIII
DAY/TIME	9.00 a.m TO 09.50 a.m	09.50a.m TO 10.40 a.m	10.40 a.m TO 10.55 a.m	10.55 a.m TO 11.45 a.m	11.45 a.m TO 12.35 p.m.	12.35 p.m. TO 1.20 p.m.	1.20 p.m TO 2.05 p.m	2.05 p.m TO 2.50 p.m	2.50 p.m TO 3.05 p.m	3.05 p.m TO 3.50 p.m	3.50 p.m TO 4.30 p.m
MONDAY	TD		BREAK			LUNCH			BREAK		
TUESDAY					TD						
WEDNESDAY	TD	TD									
THURSDAY					TD						
FRIDAY							TD				
SATURDAY					TD						

S.No	Subject code	Name of the Subject	Abbreviation	Name of the Staff & Dept	No of hours
1	EE3401	Transmission & Distribution	TD	K.VANITHA EEE	
				TOTAL	

	Prepared by	Verified by	Authorized by
Sign:	K.Vanitha	[signature]	[signature]
Name:	K.VANITHA	S.MOHANRAJ	
	FACULTY	HOD	PRINCIPAL

ॐ

SASURIE COLLEGE OF ENGINEERING

SASURIE INSTITUTIONS

Vijayamangalam, Tiruppur

Department of Electrical and Electronics Engineering

Academic Year: 2023-24 **Years / Semester:** II / III

S.No	REG.NO	STUDENT NAME	H/D
1	732422105001	M.EMEE	H

	Prepared By	Verified By
Sign:	K. Vanitha	Moharaj
Name:	K. VANITHA	S. MOHANRAJ
	Faculty	HoD

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SASURIE COLLEGE OF ENGINEERING

SASURIE INSTITUTIONS

Vijayamangalam, Tiruppur

SUBJECT INFORMATION RECORD

Department : EEE

Subject : Transmission & Distribution

Year : II

Semester : IV

Last year handled by : —

Percentage of Result (last year) : 75 %

Quality Objectives :

- To Impart Knowledge about the Configuration of the Power system.
- To study the line Parameters and interference with neighbouring ckts.

Reference Book :

Principles of Power system by. V.K Metha & Rohit metha

	Prepared By	Approved By
Sign:	K. Vanitha	[signature]
Name:	K.VANITHA.	S.MOHANRAJ
	Faculty	HOD

REFERENCES

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-		2	3			-	-	2	-	-	-
2	3	2	-	-		3	3	-			-	2	-	-	-
3	3	-	1	-		2	2		-		-	2	-	-	-
4	3	2	1	1	-	2	2				-	2	-	-	-
5	3	2	1	-	-	2	2	-	-	-	-	1	-	-	-
Avg	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-

EE3401 TRANSMISSION AND DISTRIBUTION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge about the configuration of the electrical power systems.
- To study the line parameters and interference with neighboring circuits.
- To understand the mechanical design and performance analysis of transmission lines.
- To learn about different insulators and underground cables.
- To understand and analyze the distribution system.

UNIT I TRANSMISSION LINE PARAMETERS 9

Structure of electric power system - Parameters of single and three phase transmission lines with single and double circuits -Resistance, inductance, and capacitance of solid, stranded, and bundled conductors - Typical configuration, conductor types - Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD; skin and proximity effects - Effects of earth on the capacitance of the transmission line - interference with neighboring communication circuits.

UNIT II MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9

Performance of Transmission lines – short line, medium line and long line – equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance – transmission efficiency and voltage regulation, real and reactive power flow in lines – Power Circle diagrams – Ferranti effect – Formation of Corona – Critical Voltages – Effect on line Performance.

UNIT III SAG CALCULATION AND LINE SUPPORTS 9

Mechanical design of overhead lines – Line Supports –Types of towers – Tension and Sag Calculation for different weather conditions – Methods of grounding - Insulators: Types, voltage distribution in insulator string, imorovement of string efficiency, testing of insulators.

UNIT IV NDERGROUND CABLES 9

Underground cables – Types of cables – Construction of single-core and 3-core belted cables – Insulation Resistance – Potential Gradient – Capacitance of single-core and 3-core belted cables – Grading of cables – Power factor and heating of cables– DC cables.

UNIT V DISTRIBUTION SYSTEMS 9

Distribution Systems – General Aspects – Kelvin's Law – AC and DC distributions –Concentrated and Distributed loading- Techniques of Voltage Control and Power factor improvement – Distribution Loss – Types of Substations – Trends in Transmission and Distribution: EHVAC, HVDC and FACTS (Qualitative treatment only).

TOTAL: 45 PERIODS

TEXT BOOKS:

1. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.
2. C.L.Wadhwa, 'Electrical Power Systems', New Age International Ltd, seventh edition 2022.
3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2008.

REFERENCE BOOKS:

1. B.R.Gupta, 'Power System Analysis and Design' S. Chand, New Delhi, Sixth Edition, 2011.
2. Luces M.Fualken berry, Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education, 2007.
3. Arun Ingole, "Power transmission and distribution" Pearson Education, first edition, 2018
4. J.Brian Hardy and Colin R.Bayliss 'Transmission and Distribution in Electrical Engineering', Newnes; Fourth Edition, 2011.
5. G.Ramamurthy, "Handbook of Electrical power Distribution," Universities Press, 2013.
6. V.K.Mehta, Rohit Mehta, 'Principles of power system', S. Chand & Company Ltd, New Delhi, 2013
7. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 3rd Edition, 23rd reprint, 2015.
8. R.K.Rajput, 'A Text Book of Power System Engineering' 2nd edition, Laxmi Publications (P) Ltd, New Delhi, 2016.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

CO1 : Understand the structure of power system, computation of transmission line parameters for different configurations.

CO2 : Model the transmission lines to determine the line performance and to understand the impact of Ferranti effect and corona on line performance.

CO3 : Do Mechanical design of transmission lines, grounding and to understand about the insulators in transmission system.

CO4 : Design the underground cables and understand the performance analysis of underground cable.

CO5 : Understand the modelling, performance analysis and modern trends in distribution system.

SASURIE COLLEGE OF ENGINEERING

LESSON PLAN

Faculty Name : K.VANITHA

Department : EEE   Semester/ Year: IV / II

Subject / Code : TRANSMISSION AND DISTRIBUTION/EE3401

Academic Year : 2023-2024

S.No.	Proposed Date	Period	Details of Topic Covered	TA	Ref.	Actual Date	Actual Period	HOD
			UNIT I TRANSMISSION LINE PARAMETERS					
1	4.3.24	1	Structure of electric power system	1	1	4.3.24	1	
2	5.3.24	4	Parameters of single and three phase transmission lines with single and double circuits	1	1	5.3.24	4	
3	6.3.24	1,2	Resistance, inductance, and capacitance of solid, stranded, and bundled conductors	1	1	6.3.24	1,2	
4	7.3.24	4	Typical configuration, conductor types	1	1	7.3.24	4	
5	8.3.24	5	Symmetrical and unsymmetrical spacing and transposition	1	1	8.3.24	5	
6	9.3.24	4	application of self and mutual GMD	1	1	9.3.24	4	
7	11.3.24	1	skin and proximity effects	1	1	11.3.24	1	
8	12.3.24	4	Effects of earth on the capacitance of the transmission line	1	1	12.3.24	4	
9	13.3.24	1,2	interference with neighboring communication circuits	1	1	13.3.24	1,2	
			UNIT II-MODELLING AND PERFORMANCE OF TRANSMISSION LINES					
10	14.3.24	4	Performance of Transmission lines – short line, medium line and long line	1	1	14.3.24	4	
11	15.3.24	5	equivalent circuits, phasor diagram	1	1	15.3.24	5	
12	16.3.24	4	attenuation constant, phase constant, surge impedance	1	1	16.3.24	4	
13	18.3.24	1	transmission efficiency and voltage regulation	1	1	18.3.24	1	
14	19.3.24	4	real and reactive power flow in lines	1	1	19.3.24	4	
15	20.3.24	1,2	Power Circle diagrams	1	1	21.3.24	4,5	
16	21.3.24	4	Ferranti effect	1	1	21.3.24	5	
17	22.3.24	5	Formation of Corona	1	1	22.3.24	5	
18	23.3.24	4	Critical Voltages – Effect on line Performance	1	1	23.3.24	4	
			UNIT III-SAG CALCULATION AND LINE SUPPORTS					
19	26.3.24	4	Mechanical design of overhead lines	1	1	26.3.24	4	
20	27.3.24	1,2	Line Supports	1	1	27.3.24	4,5	
21	28.3.24	4	Types of towers	1	1	28.3.	4	
22	29.3.24	5	Tension and Sag Calculation for different weather conditions	1	1	29.3.24	5	
23	30.3.24	4	Methods of grounding	1	1	30.3.24	4	
24	1.4.24	1	Insulators Types, voltage distribution in insulator string.	1	1	1.4.24	1	
25	2.4.24	4	improvement of string efficiency, testing of insulators	1	1	2.4.24	4	

SASURIE COLLEGE OF ENGINEERING

LESSON PLAN

Faculty Name : K.VANITHA

Department : ECE Semester/ Year: IV / II

Subject / Code : TRANSMISSION AND DISTRIBUTION/EE3401

Academic Year : 2023-2024

S.No.	Proposed Date	Period	Details of Topic Covered	TA	Ref.	Actual Date	Actual Period	HOD
			UNIT IV-UNDERGROUND CABLES					
26	3.4.24	1,2	Underground cables	1	1	3-4-24	1,2	
27	4.4.24	4	Types of cables	1	1	4.4.24	4	
28	5.4.24	5	Construction of single-core and 3-core belted cables	1	1	5-4-24	5	
29	6.4.24	4	Insulation Resistance	1	1	6-4-24	4	
30	8.4.24	1	Potential Gradient	1	1	8-4-24	1	
31	9.4.24	4	Capacitance of single-core and 3-core belted cables	1	1	9-4-24	4	
32	10.4.24	1,2	Grading of cables,Power factor and heating of cables	1	1	10.4.24	1,2	
33	11.4.24	4	DC cables	1	1	11-4-24	4	
			UNIT V-DISTRIBUTION SYSTEMS					
34	12.4.24	5	Distribution Systems	1	1	12-4.24	5	
35	13.4.24	4	General Aspects-Kelvin's Law	1	1	13-4-24	4	
36	15.4.24	1	AC and DC distributions	1	1	15-4-24	1	
37	16.4.24	4	Concentrated and Distributed loading	1	1	16-4.24	4	
38	17.4.24	1,2	Techniques of Voltage Control and Power factor improvement	1	1	17-4.24	1,2	
39	18.4.24	4	Distribution Loss	1	1	18-4-24	4	
40	19.4.24	5	Types of Substations	1	1	19-4-24	5	
41	20.4.24	4	Trends in Transmission and Distribution EHVAC, HVDC and FACTS (Qualitative treatment only)	1	1	20.4.24	4	

Reference books (Ref):

1 D P Kothari, I J Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Third Edition, 2019

2 C L Wadhwa, 'Electrical Power Systems', New Age International Ltd, seventh edition 2022

3 S N Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India

Teaching Aids (TA):

1 Black Board with Chalk

2 Overhead Projector

3 LCD Projector

4 Others (Field visits, Charts, Cutset Models)

	Prepared by	Verified by	Authorized by
Sign	K.Vanitha	[signature]	[signature]
Name	K Vanitha	Mr S.Mohanraj	Dr.M.Vijayakumar
	Faculty	HOD	Principal

SASURIE COLLEGE OF ENGINEERING
Vijayamangalam, Tiruppur

TEST PLAN FOR SUBJECT

Subject : Transmission & Distribution   Faculty: K. VANITHA

Semester : IV   Year: II

Department : EEE

S. No.	Description	Planned Date/Month	Actual Conducted Date / Month	Remarks
1.	Unit test - 1	25.3.2024	25.3.2024	–
2.	Unit test - 2	15.4.2024	15.4.2024	–
3.	Unit test - 3	9.5.2024	9.5.2024	–
4	Model Exam - I	27.5.2024	27.5.2024	–
5.	Model Exam - II	10.6.2024	10.6.2024	–
6	Model Exam - III	24.6.2024	24.6.2024	–

	Prepared By	Approved By
Sign:	K. Vanitha	[signature]
Name:	K. VANITHA	S. MOHANRAJ
	Faculty	HOD

SASURIE
INSTITUTIONS

SASURIE COLLEGE OF ENGINEERING

Vijayamangalam, Tiruppur

RESULT ANALYSIS OF TEST

Subject : Transmission & Distribution   Date : 28.3.24

Class : II yr   Department :

Semester : IV

Exam details & date : 25.3.24 Unit test. 1

Faculty : K. VANITHA

Number of students : 1

No. of students attended : 1

No. of students absent : 0

No. of students passed : 1

No. of students failed : 0

Percentage of failures : 0 %

RESULT DATA:

Marks	0-25	26-50	51-75	76-90	91-100
No. of Students	–	–	–	1	–

	Prepared By	Approved By
Sign:	K. Vanitha	[signature]
Name:	K. VANITHA	S. MOHANRAJ
	Faculty	HOD

SASURIE COLLEGE OF ENGINEERING

RESULT ANALYSIS OF TEST

Subject	:	[illegible]	Date	: 20-4-24
Class	:	II	Department	: EEE
Semester	:	IV		

Exam details & date	:	Unit test - 2 15-4-24
Faculty	:	K. VANITHA
Number of students	:	1
No. of students attended	:	1
No. of students absent	:	-
No. of students passed	:	1
No. of students failed	:	-
Percentage of failures	:	0 %

RESULT DATA:

Marks	0-25	26-50	51-75	76-90	91-100
No. of Students	-	-	-	88	-

	Prepared By	Approved By
Sign:	K. Vanitha	[signature]
Name:	K. VANITHA	S. MOHANRAJ
	Faculty	HOD

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SASURIE INSTITUTIONS

SASURIE COLLEGE OF ENGINEERING

Vijayamangalam - Tiruppur

RESULT ANALYSIS OF TEST

Subject : Transmission & Distribution   Date : 12-5-2024

Class : II Yr   Department : EEE

Semester : IV

Exam details & date : Unit test - 3 7.5.2024

Faculty : K. VANITHA

Number of students : 1

No. of students attended : 1

No. of students absent : –

No. of students passed : 1

No. of students failed : 0

Percentage of failures : 0%

RESULT DATA:

Marks	0-25	26-50	51-75	76-90	91-100
No. of Students	–	–	70	–	–

	Prepared By	Approved By
Sign:	K. Vanitha	[signature]
Name:	K-VANITHA.	S. MOHANRAJ
	Faculty	HOD

SASURIE COLLEGE OF ENGINEERING

RESULT ANALYSIS OF TEST

Subject : Transmission & Distribution Date : 30.5.24

Class : 2 yr Department : EEE

Semester : IV

Exam details & date : Model Exam 2 27.5.24

Faculty : K. Vanitha

Number of students : 1

No. of students attended : 1

No. of students absent : -

No. of students passed : 1

No. of students failed : -

Percentage of failures : 0 %

RESULT DATA:

Marks	0-25	26-50	51-75	76-90	91-100
No. of Students	-	-	-	87	-

	Prepared By	Approved By
Sign:	K. Vanitha	[signature]
Name:	K. Vanitha	Saravanan
	Faculty	HOD

SASURIE
COLLEGE OF ENGINEERING

RESULT ANALYSIS OF TEST

Subject : Transmission & Distribution   Date : 15-6-24

Class : II EEE   Department : EEE

Semester : IV

Exam details & date : Model Exam-II - 10-6-24

Faculty : K. VANITHA

Number of students : 1

No. of students attended : 1

No. of students absent : 0

No. of students passed : 1

No. of students failed : –

Percentage of failures : –

RESULT DATA:

Marks	0-25	26-50	51-75	76-90	91-100
No. of Students	–	–	–	1	–

	Prepared By	Approved By
Sign:	K. Vanitha	[illegible]
Name:	K. VANITHA	S. [illegible]
	Faculty	HOD

SASURIE COLLEGE OF ENGINEERING

Vijayamangalam, Tiruppur

CORRECTIVE ACTION REPORT

Dept : EEE　　　　Year : II

Subject : Transmission & Distribution　　　　Semester : IV

S.No	Internal Test	Percentage of marks	Root Cause (Metrics)	Corrective Action	Deadline date	Remarks
1.	I	100%	-	-	-	-
2.	II	100%	-	-	-	-
3.	Model Exam	100%	-	-	-	-

	Prepared By	Approved By
Sign:	K. Vanitha	[signature]
Name:	K VANITHA	S. MOHANRAJ
	Faculty	HOD

SASURIE

QUALITY OBJECTIVE MONITORING RECORD

Department : EEE

Year : II

Semester : IV

Subject : Transmission & Distribution

S.No	Quality Objective	Internal Test I		Internal Test II		Model Test I	
		Expecting result	Obtained result	Expecting result	Obtained result	Expecting Result	Obtained result
1.	To impart knowledge about [illegible] configuration of [illegible] to study the line [illegible] and [illegible]	100 %	100 %	100 %	100 %	100 %	100 %

	Prepared By	Approved By
Sign	K. Vanitha	[signature]
Name	K. VANITHA	[illegible]
	Faculty	HoD

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SASURIE INSTITUTIONS

SASURIE COLLEGE OF ENGINEERING

Vijayamangalam, Tiruppur.

ASSESMENT DETAILS(Web Portal-I)

Department of Electrical and Electronics Engineering

YEAR/SEM: II / IV

DATE: 29.04.2024

Sl. No	Register Number	Student's Name	SUBJECT NAME	ST-1	ST-2	ST-3	ST (30)	UT-1	UT-2	UT (30)	ASSIGN MENT (40)	TOTAL HR	ATTENDED	INT MARK (100)
1	732422105001	EMEE.M	ESS	22	22	18	25	35	19	16	40	15	13	81
			TD	24	21	23	27	42	44	25	40	25	23	92
			LIC	22	19	21	25	37	25	19	40	25	23	84
			MPMC	20	19	16	22	32	35	20	40	25	23	82
			MI	21	22	23	26	40	43	25	40	25	23	91
			EM-II	22	20	23	26	45	46	27	40	25	23	93

	Prepared by	Verified by	Approved by
Sign:	[signature]	[signature]	[signature]
Name:	Mrs.K.VANITHA	Mr.S.MOHANRAJ	Dr.M VIJAYAKUMAR
	Class Advisor	HOD	Principal

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SASURIE COLLEGE OF ENGINEERING

SASURIE INSTITUTIONS

Vijayamangalam, Tiruppur.

ASSESMENT DETAILS(Web Portal-II)

Department of Electrical and Electronics Engineering

YEAR/SEM: II / IV **DATE:12.6.24**

Sl. No	Register Number	Student's Name	SUBJECT NAME	UT-3 (50)	Model exam(100)	UT (60)	ASSIGN MENT (40)	TOTAL HR	ATTENDED	INT MARK (100)
1	732422105001	EMEE.M	ESS	41	85	50	40	23	23	90
			TD	35	88	49	40	30	30	89
			LIC	38	82	48	40	30	30	88
			MPMC	40	75	46	40	30	30	86
			MI	38	87	50	40	30	30	90
			EM-II	34	85	48	40	30	30	88
			EM-II LAB	_	90	_	_	45	43	90
			LIC LAB	_	88	_	_	45	42	88
			MPMC LAB	_	92	_	_	45	43	92

	Prepared by	Verified by	Approved by
Sign:			
Name:	Mrs.K.VANITHA	Mr.S.MOHANRAJ	Dr.M.VIJAYAKUMAR
	Class Advisor	HOD	Principal

SASURIE
COLLEGE OF ENGINEERING
[illegible]

Internal Test I			Date/Session	[illegible]	Marks: 50
Course code	EE3401	Course Title	Transmission and distribution		
Regulation	2021	Duration	1hr 30 minutes	Academic Year	2023-24
Year	II	Semester	IV	Department	EEE

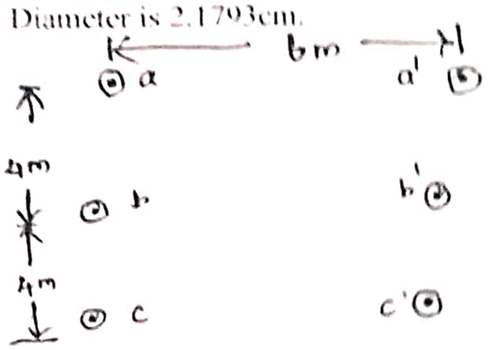
COURSE OUTCOMES

CO1:	Understand the structure of power system, computation of transmission line parameters for different configurations.
CO2:	Model the transmission lines to determine the line performance and to understand the impact of Ferranti effect and corona on line performance.
CO3:	Do Mechanical design of transmission lines, grounding and to understand about the insulators in transmission system.
CO4:	Design the underground cables and understand the performance analysis of underground cable.
CO5:	Understand the modelling, performance analysis and modern trends in distribution system

Q.No.	Question	CO	BTS
	PART A **(Answer all the Questions 10 x 2 = 20 Marks)**		
1	What is skin effect? Mention its effect on the resistance of the line	CO3	R
2	A single phase transmission line has two parallel conductors 3 m apart, the radius of each Conductors being 1 cm. calculate the loop inductance per km length of the line if the material of the conductor is copper	CO2	R
3	Differentiate between bundled conductors and stranded conductors	CO 2	R
4	Define ACSR. What are the types of conductors?	CO2	R
5	What is Transposition? Why are the transmission line transposed?	CO3	R
6	Define proximity effect on conductor.	CO3	R
7	What are the line parameters of Transmission line.	CO 3	R
8	Define capacitance of line?	CO 2	R
9	Define Self GMD and Mutual GMD?	CO 2	R
10	What are the advantages of bundled conductors?	CO2	R

PART B

(Answer all the Questions 2 x 15 = 30 Marks)

11	Deduce an expression for capacitance of three phase transmission line with unsymmetrical spacing. (Transposed conductors)	CO1	A
12	Determine the capacitance/ phase of the double circuit line as shown in the fig. the Diameter is 2.1793cm. 	CO1	R

Course Faculty
(Name /Sign / Date)
K.VANITHA

HoD
(Name /Sign / Date)
S.MOHANRAJ

Principal
(Name /Sign / Date)
M.VIJAYAKUMAR

SASURIE
COLLEGE OF ENGINEERING
Vijayamangalam, Tiruppur

SASURIE INSTITUTIONS

Internal Test-2				Date/Session	15-4-24	Marks	50
Course code	EE3401	Course Title		Transmission and distribution			
Regulation	2021	Duration		1hr 30 minutes		Academic Year	2023-24
Year	II	Semester		IV		Department	EEE

COURSE OUTCOMES

CO1:	Understand the structure of power system, computation of transmission line parameters for different configurations.
CO2:	Model the transmission lines to determine the line performance and to understand the impact of Ferranti effect and corona on line performance.
CO3:	Do Mechanical design of transmission lines, grounding and to understand about the insulators in transmission system.
CO4:	Design the underground cables and understand the performance analysis of underground cable.
CO5:	Understand the modelling, performance analysis and modern trends in distribution system

Q.No.	Question	CO	BTS
	PART A (Answer all the Questions 10 x 2 = 20 Marks)		
1	Write the formula for finding surge impedance of transmission line.	CO3	R
2	Give the length wise classification of transmission lines.	CO2	R
3	Mention the significance of Surge impedance loading.	CO 2	R
4	What are the ABCD constants and give its units?	CO2	R
5	Write an expression for the power loss due to corona.	CO3	R
6	Define proximity effect on conductor.	CO3	R
7	Define critical disruptive voltage	CO 3	R
8	What is effect of leading power factor on voltage regulation of a short transmission line?	CO 2	R

9	What is corona?	CO 2	R
10	What is the range of surge impedance in a underground cable?	CO2	R

PART B
(Answer all the Questions 2 x 15 = 30 Marks)

11	Explain the classification of transmission lines with their characteristics	CO3	A
12	i) Define a) Surge impedance. (b) Attenuation constant (c) Voltage regulation (d) Transmission efficiency. (8) ii) A 50 Hz .3 phase transmission 30 Km long has a total series impedance of(40+j125)Ω and shunt admittances of 10^{-3} mho .The load is 50 MW at 220 KV with 0.8 Pf lag . Find the sending end voltage, current, power factor, efficiency and regulation using nominal π method. (7)	CO2	A

K. Vanitha 15/4/24

Course Faculty
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HoD
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Principal
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M.VIJAYAKUMAR

Internal Test 1

Course code	[illegible]	Course title	Date/Session	[illegible]	Marks	[illegible]
Regulation	[illegible]	Duration	Transmission and Distribution			
Year	[illegible]	Semester	[illegible]		Academic Year	[illegible]
[illegible]			[illegible]		Department	[illegible]

CO1:	Understand the structure of power system, computation of transmission line parameters for different configurations
CO2:	Model the transmission lines to determine the line performance and to understand the impact of Corona effect and ferranti on line performance
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Q.No	Question	CO	BTL
	PART A (Answer all the Questions 10 x 2 = 20 Marks)		
1	Define sag	CO3	R
2	What is stringing chart? What is its use?	CO3	R
3	What is the effect of wind and ice loading on sag?	CO3	R
4	What is the economical value of span for 400kV transmission line?	CO3	R
5	Give the expression of sag when the supports are at equal level	CO3	R
6	Give the minimum ground clearance required for 33kV, 66kV, 110kV and 230kV lines	CO3	R
7	What are the methods of improving string efficiency?	CO3	R
8	What are the advantages of suspension type insulator?	CO3	R

9	Give the importance of stay insulator.	CO 3	R
10	What is ACSR?	CO 3	R
PART B (Answer all the Questions 2 x 15 = 30 Marks)			
11	Draw with neat sketches and explanation of different types of insulators. Compare their merits and demerits	CO 3	A
12	A transmission line has a span of 275 m between level supports. The conductor has effective diameter of 1.96 cm and weights 0.865 kg/m. Its ultimate strength is 8060 kg. If the conductor has ice coating of radial thickness 1.27 cm and is subjected to a wind pressure of 39kg/m2 of projected area, calculate the maximum sag. Assume that the safety factor is 2 and ice weighs 910 kg/m3	CO 3	A

K. Vanitha 9/5/24

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SASURIE
COLLEGE OF ENGINEERING

Model Examination - I				Date/Session	15.5.24	Marks	100
Course code	EE3401	Course Title	Transmission and distribution				
Regulation	2021	Duration	3 Hours	Academic Year	2023-24		
Year	II	Semester	IV	Department	EEE		

COURSE OUTCOMES

CO1:	Understand the structure of power system, computation of transmission line parameters for different configurations.
CO2:	Model the transmission lines to determine the line performance and to understand the impact of Ferranti effect and corona on line performance.
CO3:	Do Mechanical design of transmission lines, grounding and to understand about the insulators in transmission system.
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Q.No.	Question	CO	BTS
	PART A **(Answer all the Questions 10 x 2 = 20 Marks)**		
1	What are the advantage of using bundle conductors?	CO3	R
2	List out the parameters affecting skin effects in transmission line.	CO2	R
3	What is the effect of leading load power factor on voltage regulation of a short transmission line?	CO 2	R
4	What are the disadvantages of corona?	CO2	R
5	What are types of line supports used in transmission and distribution systems?	CO3	R
6	What are the factors affecting the sag in a transmission line?	CO3	R
7	What are the desirable characteristics of insulating materials used in cables?	CO 3	R
8	What are the sources of heat generation in an underground cable?	CO 2	R
9	What are the limitations of Kelvin's law?	CO 2	R
10	What are advantages of FACTS controllers?	CO2	R
	PART B **(Answer all the Questions 5 x 13 = 65 Marks)**		
11a	Explain the structure of electric power system in detail	CO1	A
	OR		

11b	(i) Compare the overhead and underground distribution system. (7) (ii) Sate the advantages of interconnected system. (6)	CO1	R
12a	Explain the factors affecting corona loss and methods of reducing corona loss.	CO2	R
OR			
12b	Derive the expression for inductance of a three phase transmission line with unsymmetrical Spacing	CO2	A
13 a	Derive the expression for the real and reactive power flow through transmission lines	CO2	E
OR			
13b	Deduce the expression for the sending end and receving end power of a transmission line in terms of voltages and ABCD constants	CO2	A
14a	Derive voltage regulation, power factor and transmission and transmission efficiency of short transmission line with diagrams	CO2	R
OR			
14b	Find the voltage drop on a DC distributed having concentrated loads and unifoem loads, supplied to both ends with i)equal voltages ii) unequal voltages.	CO3	R
15a	Explain the following : i) Theory of corona formation ii) Factors affecting corona iii) Disruptive critical voltage iv) Visuval critical voltage v) Corona power loss	CO3	A
OR			
15b	Derive the expression for line to line capacitance of a single phase two wire line and also find the capacitive reactance between one conductor to neutral	CO1	R
PART C (Answer all the Questions 1 x 15 = 15 Marks)			
16a	What are the different methods available for Voltage control and explain any one method	CO1	R
OR			
16b	i)Explain the different HVDC links.(7) ii)Make a comparison between EHVAC and HVDC system based on economics	CO2	R

K.Vanitha 25/5/24

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M.VIJAYAKUMAR

SASURIE
COLLEGE OF ENGINEERING

Model Examination - 2			Date/Session	[illegible].6.24	Marks 100
Course code	EE3401	Course Title	Transmission and distribution		
Regulation	2021	Duration	3 Hours	Academic Year	2023-24
Year	II	Semester	IV	Department	EEE

COURSE OUTCOMES

CO1:	Understand the structure of power system, computation of transmission line parameters for different configurations.
CO2:	Model the transmission lines to determine the line performance and to understand the impact of Ferranti effect and corona on line performance.
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CO4:	Design the underground cables and understand the performance analysis of underground cable.
CO5:	Understand the modelling, performance analysis and modern trends in distribution system

Q.No.	Question	CO	BTS
	PART A **(Answer all the Questions 10 x 2 = 20 Marks)**		
1	Why the concept of self GMD is not applicable for capacitance calculation?	CO3	R
2	What is meant by skin effect?	CO2	R
3	Define Ferranti effect.	CO 2	R
4	Write the formula for surge impedance of transmission line.	CO2	R
5	List the significance of a stringing chart.	CO3	R
6	Define String efficiency	CO3	R
7	What are the sources of heat generation in an underground cable?	CO 3	R
8	What is a belted-Cable?	CO 2	R
9	What are the various types of HVDC systems?	CO 2	R
10	What are advantages of FACTS controllers?	CO2	R
	PART B **(Answer all the Questions 5 x 13 = 65 Marks)**		
11a	Derive an expression for loop inductance of a single phase transmission system.	CO1	A
	OR		

11b	Derive the expression for capacitance of three-phase transmission line with symmetrical and unsymmetrical spacing	CO1	R
12a	Three phase 5km long transmission line, having resistance of 0.502/km and inductance of 1.76 mH /km is delivering power at 0.8 pf lagging. The receiving end voltage is 32kV. If the supply end voltage is 33 kV, 50 Hz, find (i) Line current (5). (ii) Regulation (4) (iii) Efficiency of the transmission line. (4)	CO2	R
OR			
12b	Assume a three-phase line has the impedance of 5+j20 ohm per phase delivers a load of 30MW at a power factor of 0.8 lag and voltage of 33kV. Determine the capacity of the phase modifier to be installed at the receiving end if the voltage at sending end is to be maintained at 33kV.Assume the shunt admittance is neglected.	CO2	A
13 a	A transmission line conductor is supported on the towers of equal height. The height of each tower is 30 m. The distance between the towers is 160 m, tension in the conductor is 2500 kg and cross sectional area of conductor is 2.5 cm2. Compute the sag.	CO2	E
OR			
13b	In a 33 kV overhead line, there are three units in the string of insulators. If the capacitance between each insulator pin and earth is 11% of self capacitance of each insulator, find the distribution of voltage over 3 insulators and string efficiency. Draw the equivalent circuit.	CO2	A
14a	Explain, the methods of grading of cables with neat diagrams and equations	CO2	R
OR			
14b	Derive the expression for insulation resistance, capacitance, electric stress and dielectric loss of a single core cable	CO3	R
15a	Explain, with a neat layout the modern EHV system. What is the highest voltage level available in India for EHV transmission?	CO3	A
OR			
15b	Find the ratio of volume of copper required to transmit the power over a given distance, by overhead system using, (i) DC 2 wire and 3 wire system, (7) (ii) 3 phase, 3 wire AC systems. (6)	CO1	R
PART C			
(Answer all the Questions 1 x 15 = 15 Marks)			
16a	A uniform two wire DC distributor 250m long is loaded with 0.4 A/m and is fed at one end. If the maximum permissible voltage drop is not exceed 10V, find the cross sectional area of the distributor conductor. Take $\rho = 1.78 \times 10^{-8}$ m	CO1	R
OR			
16b	A 220 KV, 50 HZ, 200 Km long three phase line, has its conductors on the corners of a triangle with sides 6m, 6m and 12m. The conductor radius is 1.81 cm. Find the charging current, inductance and capacitance per phase per Km	CO2	R

K.Vanitha 10/6/24

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Slip test Question

Slip test 1

PART A

1. Define Resistance?
2. What is Inductance?
3. Write the equation of Capacitance
4. What is skin effect
5. What is flux linkages?

PART B

1. Explain about Typical A.C power supply scheme
2. Deduce the expression for Capacitance of 3ϕ Tr. line with Symmetrical Spacing?

Slip test 2

PART A

1. What are effects of Capacitance
2. What is meant by Proximity effect
3. What is Transposition of Conductors
4. What are the different types of Conductors
5. Define Self GMD & Mutual GMD

PART B

1. Explain about the Inductance of a single phase Tr. line.

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SASURIE COLLEGE OF ENGINEERING

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Approved by AICTE New Delhi
Affiliated to Anna University Chennai

Internal Assessment Test Answer Book

Name	M.EMEE			Year/ Semester/Section	II / IV
Batch No.		Date/Session	25.3.2024	Department	EEE
Course code	EE3401	Course Title	Transmission & Distribution		
Internal Assessment Test		IAT 1 ☑	IAT 2 ☐	IAT 3 ☐	Model ☐
Name and Signature of the Invigilator with date			K.Vanitha 25/3.		

Instruction to the Student: Put tick mark to the question attended in the column against question.

Part A			Part B/ Part C					Total Marks
Q. No.	✓	Marks	Q. NO.	✓	a Marks	✓	b Marks	
1	✓	2	11	✓	14			14
2	✓	2	12	✓	12			12
3	✓	2	13					
4			14					
5	✓	2	15					
6	✓	2	16					
7							Grand Total	26
8	✓	2						
9	✓	2			42		K.Vanitha 27/3/24.	
10	✓	2						
Total		16			Grand Total		Name and Signature of the Examiner with date	

To be filled by the examiner

Course Outcomes	1	2	3	4	5	6	Total
Marks allotted	30	12	8				50
Marks Obtained	26	10	6				42

IQAC Audit - Remarks

Marks Verified

K.G. [signature]

Name and Signature of the IQAC member

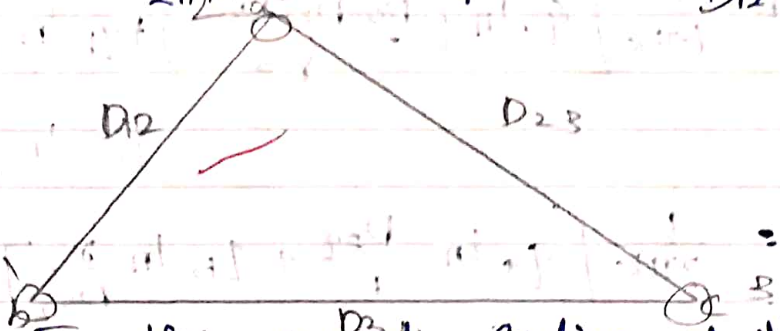
Name : M. Emee
Dept : B.E / EEE
Subname : Transmission and distribution.
Date : 25.03.24
test : Unit test -1.

15 - mark:

(11) capacitance of a three - phase line with unsymmetrical spacing:

* As the conductor are rotated cyclically in the three sections of the transposition cycle correspondingly three expression can be written of Vab.

$$V_{ab} = \frac{1}{2\pi k}\left(q_{a1} \ln \frac{D_{12}}{r} + q_{b1} \ln \frac{r}{D_{12}} + q_{c1} \ln \frac{D_{23}}{D_{31}}\right)$$



* For the second section of the transposition cycle,

$$V_{ab} = \frac{1}{2\pi k}\left[q_{a2} \ln \frac{D_{23}}{r} + q_{b2} \ln \frac{r}{D_{23}} + q_{c2} \ln \frac{D_{31}}{D_{12}}\right)$$

* For the third secontion of the transposition cycle.

$$V_{ab} = \frac{1}{2\pi k}\left[q_{a3} \ln \frac{D_{31}}{r} + q_{b3} \ln \frac{r}{D_{31}} + q_{c3} \ln \frac{D_{12}}{D_{23}}\right].$$

* If the voltage drooping along the line is neglected. Vab is the same in each

transposition cycle. On similar lines three such equation can be written for $V_{ac} = V_{ab} \angle -120°$.

* Three more equation can be written equation to zero the summation of all line charge.
* The rigorous solution though possible is too involved.
* $q_{a1} = q_{a2} = q_{a3} = q_a$; $q_{b1} = q_{b2} = q_{b3} = q_b$

$q_{c1} = q_{c2} = q_{c3} = q_c$

* This assumption of equal charge / unit length of a line in the three section of the transposition cycle requires

$$= V_{ab}(avg) = \frac{1}{3}(V_{ab1} + V_{ab2} + V_{ab3})$$

$$* \; V_b = \frac{1}{6\pi k}\left[q_a \ln\left(\frac{D_{12}D_{23}D_{31}}{r^3}\right) + q_b \ln\left(\frac{r^3}{D_{12}D_{23}D_{31}}\right) + q_c \ln\left(\frac{D_{12}D_{23}D_{31}}{D_{12}D_{23}D_{31}}\right)\right]$$

$$= \frac{1}{2\pi k}\left[q_a \ln \frac{D_{eq}}{r} + q_b \ln \frac{r}{D_{eq}}\right] \longrightarrow (1)$$

where, $D_{eq} = (D_{12}D_{23}D_{31})^{1/3}$

$$- V_{ac} = \frac{1}{2\pi k}\left(q_a \ln \frac{D_{eq}}{r} + q_c \ln \frac{r}{D_{eq}}\right) \longrightarrow (2)$$

equ (1) and (2).

$$- V_{ab} + V_{ac} = \frac{1}{2\pi k}\left[q_a \ln \frac{D_{eq}}{r} + (q_b + q_c)\ln \frac{r}{D_{eq}}\right]$$

$V_{ab} + V_{ac} = 3V_{an}$

$(q_b + q_c) = -q_a$

Use these relation

$$V_{an} = \frac{q_a}{2\pi k} \ln \frac{D_{eq}}{r}$$

* The capacitance of line to neutral of the transposed line is then given by.

$$C_{an} = \frac{q_a}{V_{an}} = \frac{2\pi k}{\ln(D_{eq}/r)} \; F/m$$

$$C_n = \frac{0.0242}{\log(D_{eq}/r)} \; \mu F/km$$

* The line charging current of three-phase line is phase form is.

I_a (line charging) $= j\omega C_n V_{an}$ A/km.

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(12) Soln:

G.M.R of conductor $=$ [illegible]

$= 1.34$ cm

Distance of a to b $= \sqrt{[illegible]} =$ [illegible]

Distance of a to a' $= \sqrt{[illegible]} =$ [illegible]

Equivalent self G.M.D of one phase is

$$D_s = \sqrt[3]{D_{s1} \times D_{s2} \times D_{s3}}$$

Now, $D_{s1} = \sqrt[4]{D_{aa} \times D_{aa'} \times D_{a'a} \times D_{a'a'}}$

$= \sqrt[4]{(1.34 \times 10^{-2}) \times (8.48)(1.34 \times 10^{-2})(8.48)}$

$= 7.15$ km D_{s2}

$D_{s2} = \sqrt[4]{D_{bb} \times D_{bb'} \times D_{b'b} \times D_{b'b'}}$

$= \sqrt[4]{(7.69 \times 10^{-3}) \times (6) \times (7.69 \times 10^{-3}) \times (6)}$
$= 0.470\,m.$

$D_s = \sqrt[3]{(7.188 \times 0.790 \times 7.186)}$
$= 1.5.21\,m.$

Equivalent mutual (G.M.D) $= D_m = \sqrt[3]{D_{AB} \times D_{BC} \times D_{CA}}$

$D_{AB} = \sqrt[4]{D_{ab} \times D_{ab'} \times D_{a'b} \times D_{a'b'}}$

$= \sqrt{4 \times 7.2 \times 7.2 \times 4}$
$= 11.52\,m.$

$D_{CA} = \sqrt{6 \times 6 \times 6 \times 6}$
$= 6\,m$

$D_m = \sqrt[3]{11.52 \times 11.52 \times 6}$
$= 80.95\,m.$

Inductance per phase per meter length
$= 10^{-7} \times 2 \log_e D_m / D_s = 10^{-7} \times 2 \log_e 6.96 / 0.22$
$= 5.7 \times 10^{-7}\,H$
$= 5.7 \times 10^{-7} \times 1000$
$= 0.57 \times 10^{-3}\,H$

Inductance $= 0.57\,mH$.

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2 mark:

① Skin effect:

* When a conductor is carrying steady direct current, this current is uniformly distributed over the whole x-section of the conductor. However, an alternating current flowing through the conductor does not distribute uniformly. This is known as skin effect.

* The tendency of alternating current to Concentrate near the Surface of a conductor is known as skin effect.

② Solu'.

Spacing of conductor : d = 3m
= 300 cm.

Radius of conductor r = 1/2
= 0.5 cm

loop Inductance per metre length of the line,

$= 10^{-7}(1+4 \log_e d/r)$ H
$= 10^{-7}(1+4 \log_e 300/0.5)$ H
$= 10^{-7}(5 \log_e 600)$ H.
$= 10^{-7}(13.890)$ H
$= 13.890 \times 10^{-7}$ H.//

loop inductance per km of the line,

$= 13.890 \times 10^{-7} \times 1000.$
$= 13.890 \times 10^{-4}$ H
$= 13.890$ mH //

③ Bundled conductor.

* It is economical to transmit large chungs of power over long distance by employing by due to our considering Intermediate differ by the conductor!

* It's makes being the valuable due to insoured by its all critical corona voltage is dependent on number of Conductors on this group!

(6) Proximity effect

* Apart from the skin effect non-uniformity of current distribution is also caused by proximity effects.

* The flux linking loop is the least and it increases some what for loop 11' and cc'.

* Thus the density of conductor is highest inner edge & due to least at outer edge. The phenomenon is called proximity effect.

(8) Capacitance of transmission line:

* The capacitance together with conductance form the shunt admittance of a transmission line.

* The line capacitance drawn a leading sinusoidal current called a charging current.

(9) Self GMD:

* In order to have concept of self GMD and also sometime called mean radius,

$$\text{Inductance} = 2\times10^{-7}\left(\frac{1}{4}+\log_e\frac{d_1}{r}\right)$$

$$= 2\times10^{-7}\times\frac{1}{4}+2\times10^{-7}\log_e\frac{d}{r}$$

Mutual GMD:

* The mutual GMD is the geometrical mean of the distance from one conductor to the other end, therefore must be between the largest and smallest such distance.

D_m = Spacing between conductor.

$D_m = (d_1 d_2 d_3)^{1/3}$.

(10) advantages of bundled conductors:

* The bundle usually comprises two, three or four conductor arranged in configuration illustrated.

* The more the number of conductor in a bundle, the more is the self GMD.

* lower reactance of a bundled conductor line increase its transmission capacity.

* Increases in capacitance
* Increases in power capability
* Reduce the voltage surface gra
* Reduce corona loss
* Reduce surge impedence.
* Increases surge impedence lo

(5) Transposition:-

* Transposition means changing t position of three phases on the line s twice are the total length of the conductor pratice are so transposed each of three possible arrangments exists one third of the total length

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Internal Assessment Test Answer Book

Name	[illegible]	Year/Semester/Section	[illegible]
Batch No.		Date/Session	[illegible]
Department			
Course code	[illegible]	Course Title	[illegible]
Internal Assessment Test	IAT I ☐	IAT II ☐	IAT III ☐ Model ☑
Name and Signature of the Invigilator with date	[illegible]		

Instructions to the Students: [illegible]

Part A		Part B/ Part C			
Q. No.	Marks	Q. No.	a Marks	b Marks	Total Marks
1	[illegible]	11	[illegible]		[illegible]
2	[illegible]	12	[illegible]		[illegible]
3	[illegible]	13	[illegible]		[illegible]
4	[illegible]	14	[illegible]		[illegible]
5	–	15	[illegible]		[illegible]
6	[illegible]	16	–		
7	[illegible]			Grand Total	[illegible]
8	[illegible]				
9	[illegible]				
10	[illegible]				
Total	[illegible]	Grand Total	[illegible]	Name and Signature of the Examiner with date	[illegible]

To be filled by the examiner

Course Outcomes	1	2	3	4	5	6	Total
Marks allotted	[illegible]	[illegible]	[illegible]				[illegible]
Marks Obtained	[illegible]	[illegible]	[illegible]				[illegible]

IQAC audit – Remarks

Mark Verified

Name and Signature of the IQAC member

Name : M.Emee
Dept : B.E - EEE
Subj : Transmission and distribution
Subj code : EE3401
Date : 27.05.2023
test : Model Exam - I

68/100

Part - B

(11) a) Electric power supply system:

* The conveyance of electric power from a power station to consumers premises is known as electric supply system.

* An electric supply system consists of three principal components the power station transmission lines and the distribution system.

* Electric power is produced at the power station which are located as favourable place, generally quite away from the consumers.

* It is the transmitted over large distance to load centre with help of the conductor known as transmission.

* Finally, it is distributed to a large number of small and big consumers through a distribution.

The electric supply system can be broadly divided into the i, a.c to d.c system ii, overhead underground system

Typical a.c power supply system:-

* The large network of conductors between by the broadly divided into two parts transmission system and distribution system.

* And again broadly sub-division due to the primary transmission and secondary transmission and primary distribution and secondary distribution.

(i) Generating station:-

* The generating station where electric power is produced by 3-phase alternator operating in parallel.

* The usually generation voltage is 11KV.

* For economy of the transmission line electric power generation voltage is 11KV to 132 KV.

* The generation voltage was highly included into the most carefully safe such that generating valuable is under by the cables all connected the transmission voltage including broadly divisible from the accurated mission.

II) primary transmission:-

* The electric power at 132kv transmitted by the 3-phase 3-wire overhead system to the outskirts of the

city. This is known as primary transmission.

(iii) secondary transmission:-

* The primary transmission line terminates at the receiving station (RS) which usually lies to the outskirts of the city.

* At receiving station, the voltage from reducing the 132 kv it step-down transformer.

* The electric power transmitted at 33 kv and by 3-phase, 3-wire overhead the system and the strategic of the city. This is known as secondary transmission.

(iv) primary distribution:-

* The secondary transmission line terminate from sub-station (SS) where voltage is form. 33kv to 11kv.

* The 11 kv line along the most important the rode side of the city.

* This is known as primary distribution.

(v) secondary distribution:-

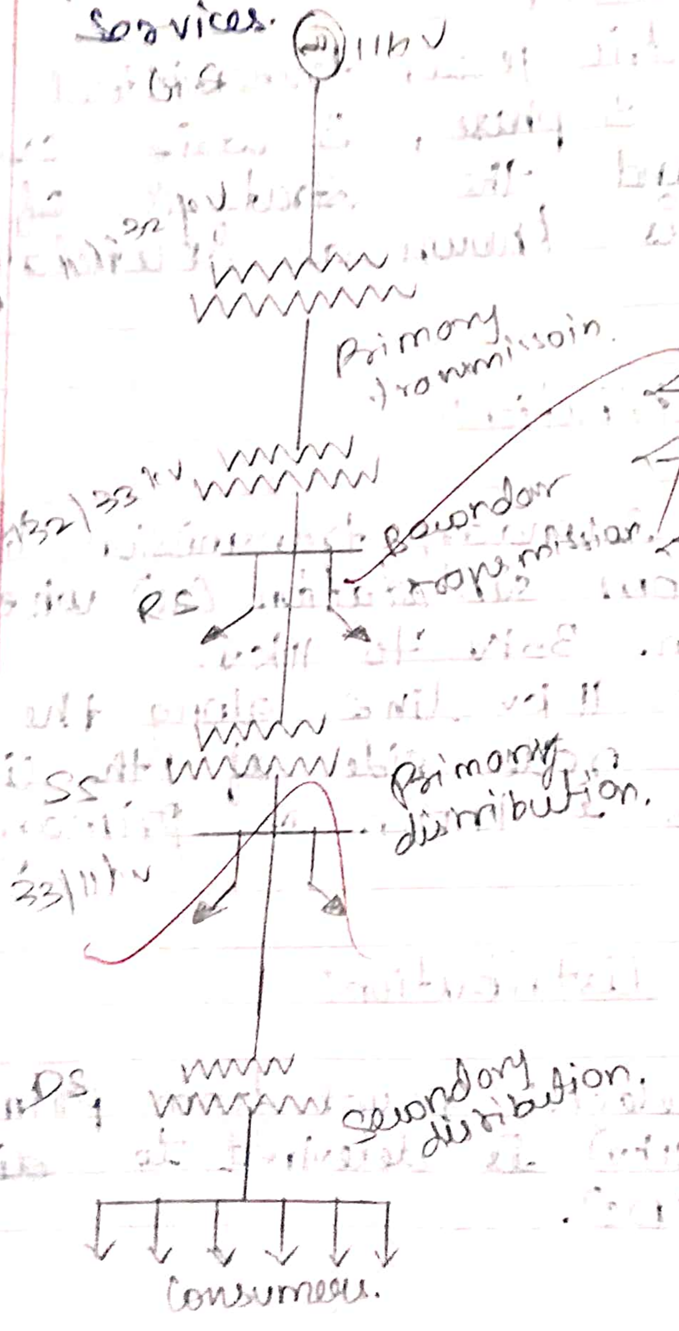
* The electric power from primary distribution (11kv) is delevired to distribution sub-station (DS).

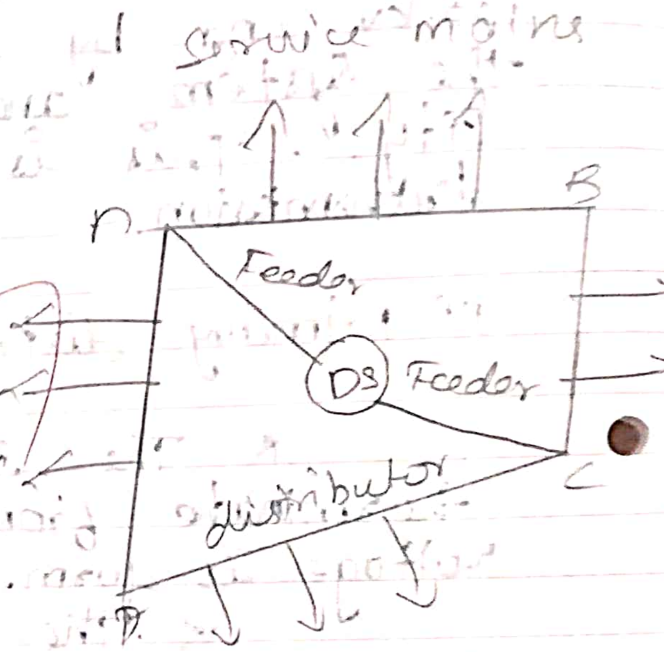
* These sub-station are located near the consumers located and step down the voltage to 400 V, 3-phase, 4 wire for secondary distribution.

* It is worthwhile to mention here the secondary distribution system consits of feeders.

* No consumers is given direct connection from the feeders.

* The consumers are conneted from their main the distributors through services.





(Q) a) Corona :-

* The phenomenon of violet glow and hissing sound and production the ozone gas in a overhead transmission line is Corona.

* when an alternating potential difference is applied across two conductor whose spacing compared to their diameter.

* However, when the applied voltage exceeds a certain value, called critical disruptive voltage. the conductor are surrounded by a faint voilet glow called corona.

* The phenomenon of corona is accompained by a hissing sound ozone, power loss and radio interface. the higher the voltage is raised.

Theory of Corona formation :-

* Some ionisation always present in air due to cosmic rays, ultra voilet, radioactivity :

* Therefore, under normal condition the air around the conductors contain some ionised particles and neutral molecules.

* The greater the applied voltage the greater the potential gradient and more is turn are accelerated until they collides with other molecules.

Factor affecting Corona:-

* The phenomenon of corona affect by the physical state of the atmosphere as well as by the condition of the line.

i) Atmosphere:-
As corona is formed due to ionisation of air surrounding the conductors. therefore it is affected by the physical state of atmosphere.

ii) Conductor size:-
The corona affects depends upon the shape and condition of the conductor. The rough and irregular surface will give rise to more corona because convexness of the surface decreases the value of break down voltage.

iii) Spacing between conductor:-
If the spacing between the conductor is made very large as compared to diameter. there may not be any corona effects. It because larger than distance between conductor reduces the electro-static stress at the conductor surface avoiding corona formation.

iv) line voltages:-
The line voltage greatly affects corona. If it is low, there is no change

in the condition of air surrounding the conductor and hence no corona is formed. However, line voltage has such a value the electro static stress developed at the conductor surface make the air around corona is formed.

Importance terms:-

i) Critical disruptive voltage:-

* It is the maximum neutral phase voltage at which corona occurs.

$$g = \frac{V}{r \log_e \frac{d}{r}} \ v/cm.$$

$$g_0 = \frac{V_c}{r \log_e \frac{d}{r}} \ v/cm.$$

$$V_c = g_0 \, r \log_e \frac{d}{r} \ v/cm.$$

$$V_c = m_0 \, g_0 \, \delta \, r \log_e \frac{d}{r} \ v/cm.$$

ii) Visual critical voltage:

* It is the maximum phase - neutral voltage at occurs which the corona was ~~transmission~~ lines.

$$V_v = m_v \, g_0 \, \delta \, r \left[1 + \frac{0.3}{\sqrt{\delta r}}\right] \log_e \frac{d}{r}.$$

iii) power losses due to:-

Formation of corona always accompained by electric power which is dissipated from the light, heat and sound and chemical action. when disruptive due to Corona due to Losses is,

$$P = 242.2 \left[\frac{\delta + 25}{\delta}\right] + \sqrt{\frac{r}{d}} (V - V_c)^2 \times 10^{-5}$$

f = frequency of Hz.

Advantages of corona:-

* Due to air formation of surrounding the conductor and from virtual diameter gets most connected by increased. The increased diameter reduced by the eletric stress static given by the Corona.

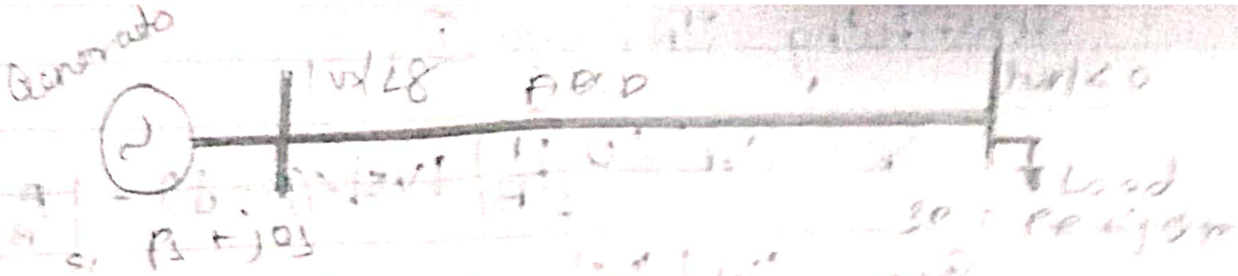
Disadvantages:-

* Corona accompained the loss energy. The transmission efficiency can be transmission line.

* Ozone produced by corona caused by corrosion and air surrounded by chemical reaction.

(13) a) power flow through a transmission line:

* The transmission line performance equation was presented in the form of voltage and current relationships between sending and receiving ends. It deals line equations by the sending ends and receiving ends. treated by power.



Let us take receiving end and sending end voltage reference phasor ($V_R = |V_R|\angle 0°$) and voltage leads it by angle the ($V_S = |V_S|\angle\delta$) while dealing with problems.

The complex power leaving from the receiving end to sending end of the transmission line can be expressed by

$$S_R = P_R + jQ_R = V_R I_R^* \longrightarrow (1)$$
$$S_S = P_S + jQ_S = V_S I_S^* \longrightarrow (2)$$

Receiving end and sending ends can be expressed by the current voltage by.

$$I_R = \frac{1}{B} V_S - \frac{A}{B} V_R \longrightarrow (3)$$

$$I_S = \frac{D}{B} V_S - \frac{1}{B} V_R \longrightarrow (4)$$

Let A, B, D the transmission line constant.

$$A = |A|\angle\alpha, \quad B = |B|\angle\beta, \quad D = |D|\angle\alpha$$
Since ($A = D$).

Therefore, we can write.

$$I_R = \left|\frac{1}{B}\right| |V_S| \angle(\delta - \beta) - \left|\frac{A}{B}\right| |V_R| \angle(\alpha - \beta) \longrightarrow$$

$$I_S = \left|\frac{D}{B}\right| |V_S| \angle(\alpha + \delta - \beta) - \left|\frac{1}{B}\right| |V_R| \angle(-\beta) \longrightarrow (6)$$

Substituting I_R, equ ①,

$$S_R = |V_R| \angle 0 \left[\left|\frac{1}{B}\right| |V_S| \angle (\beta - \delta) - \left|\frac{A}{B}\right| |V_R| \angle (\beta ...\right.$$

$$S_R = \frac{|V_R|\,|V_S|}{|B|} \angle (\beta - \delta) - \left|\frac{A}{B}\right| |V_R|^2 \angle (\beta - \alpha)$$

↳ ⑥

I_S, sub in equ ⑤.

$$S_S = |V_S| \angle 0 \left[\left|\frac{D}{B}\right| |V_S| \angle (\alpha - \beta + \delta) - \left|\frac{1}{B}\right| |V_R| \angle (-\beta) \right]$$

$$S_S = \frac{D}{B} |V_S|^2 \angle (\alpha - \beta) - \frac{|V_S|\,|V_R|}{|B|} \angle (\beta + \delta)$$

↳ ⑧

S_R multiple the (3phase VA):-

$$S_R = 3 \left[\frac{|V_S|\,|V_R| \times 10^6}{\sqrt{3}\,\sqrt{3}\,|B|} \angle (\beta - \delta) - \left|\frac{A}{B}\right| \frac{|V_R|^2 \times 10^6}{3} \angle (\beta - \alpha) \right]$$

S_R multiple the (3phase MVA):-

$$S_R = \frac{|V_S|\,|V_R|}{|B|} \angle (\beta - \delta) - \left|\frac{A}{B}\right| |V_R|^2 \angle (\beta - \alpha)$$

↳ ⑨

∴ The expressed in real and reactive power by the included by receiving ends as.

$$P_R = \frac{|V_S|\,|V_R|}{|B|} \cos (\beta - \delta) - \left|\frac{A}{B}\right| |V_R|^2 \angle (\beta - \alpha)$$

↳ 10

$$Q_R = \frac{D}{B} |V_S|^2 \angle (\alpha - \beta) - \frac{|V_S|\,|V_R|}{|B|} \angle (\beta + \delta)$$

↳ ⑪

lly, the real and reactive power sending are

$P_S = \left|\frac{D}{B}\right| |V_S|^2 \cos(\beta - \alpha) - \frac{|V_S||V_R|}{|B|} \cos(\beta + \delta)$ — (13)

$Q_S = \left|\frac{D}{B}\right| |V_S|^2 \sin(\beta - \alpha) - \frac{|V_S||V_R|}{|B|} \sin(\beta + \delta)$ — (14)

Now,

$\delta = \beta$

that

$P_R(max) = \frac{|V_S||V_R|}{|B|} \cos(0) - \left|\frac{A}{B}\right| \frac{|V_R|^2}{|B|} \cos(\beta - \alpha)$ — (15)

The Q_R (max)

$Q_R = \frac{|A||V_R|^2}{|B|} \sin(\beta - \alpha)$ — (16)

Consider $A = D = 1\angle 0$, $B = Z = |Z|\angle\theta$

$P_R = \frac{|V_S||V_R|}{|Z|} \cos(\theta - \delta) - \frac{|V_R|^2}{Z} \cos\theta$ — (17)

$Q_R = \frac{|V_S||V_R|}{|Z|} \sin(\theta - \delta) - \frac{|V_R|^2}{Z} \sin\theta$ — (18)

the receiving end for the sending end;

$P_S = \frac{|V_S|^2}{|Z|} \cos\theta - \frac{|V_S||V_R|}{|Z|} \cos(\theta + \delta)$ — (19)

$Q_S = \frac{|V_S|^2}{|Z|} \sin\theta - \frac{|V_S||V_R|}{|Z|} \sin(\theta + \delta)$ (20)

$P_R = \frac{|V_S||V_R|}{X} \sin\delta$ — (20)

$Q_R = \frac{|V_S||V_R|}{X} \cos\delta - \frac{|V_R|^2}{X}$ — (21)

TMPL

The further simplified the $\int$-1 transmission line, and

$$Q_R = \frac{|V_R|}{X}(|V_S| - |V_R|) \quad \text{--- (22)}$$

where $(|V_S| - |V_R|) = \Delta V$;

$$Q_R = \frac{|V_R|}{X}(\Delta V) \quad \text{--- (23)}$$

$$(\Delta V) = |I_R| R \cos\phi + |I_R| X \sin\phi \quad \text{--- (24)}$$

$$|\Delta V| = \frac{R P_R + X Q_R}{|V_R|} \quad \text{--- (25)}$$

(14) a) Voltage regulation:-

* When a transmission line is carrying current, then it is a voltage drop in the line due to resistance and inductance of the line.

* The result is that receiving end voltage (V_R) of the line is generally less than the sending end voltage. a percentage of receiving end voltage V_R and is called voltage regulation.

* The difference in voltage at the receiving end of a transmission line between condition of no load and full load is called voltage regulation.

(ii) Power factor:

The cosine of angle between voltage and current in an a.c circuit is known as power factor.

(iii) transmission efficiency:-

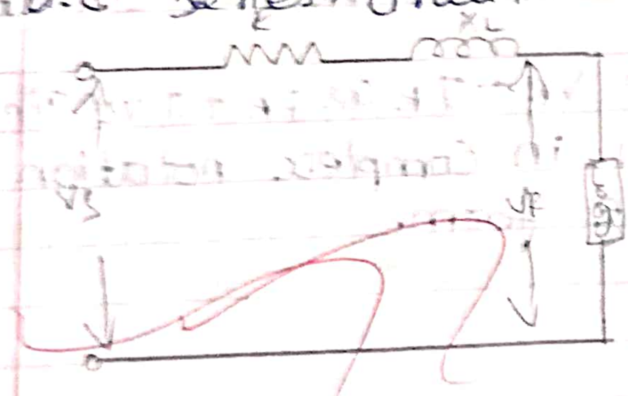
* The power obtained at the receiving end of the transmission lines is generally less than the sending end power due to losses in the line resistances.

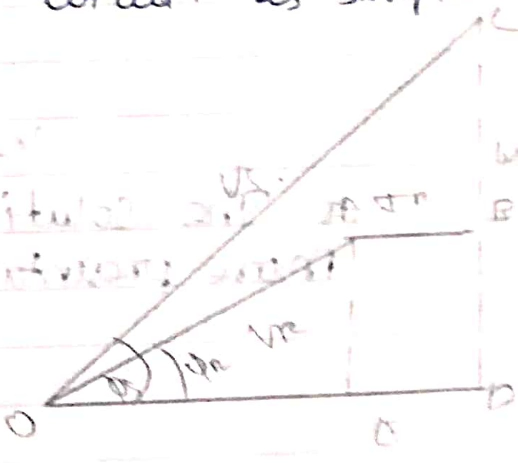
The ratio of receiving part end power to the sending end power of a transmission line is known as transmission efficiency of the line.

$$\eta_T = \frac{\text{Receiving end power}}{\text{Sending end power}} \times 100.$$

Performance of single phase short transmission line:-

As started earlier the effect of the capacitor are neglected for a short transmission line. The circuit is simple a.c. series circuit:-





$$(OC)^2 = (OD)^2 + (DC)^2$$

$$V_s^2 = (OE + ED)^2 + (DB + BC)^2$$

$$= (V_R \cos\phi_R + IR_2) + (V_R \sin\phi_R + I$$

$$V_s = \sqrt{(V_R \cos\phi_R + IR_2)^2 + (V_R \sin\phi_R + IX}$$

$OC \approx OF = OA + AF = OA + AD + DF$

$= OA + AB + BH$

$V_S = V_R + IR \cos\phi_R + IX_L \sin\phi_R$.

Solution in complex notation:

It is often convenient and profitable to make the above calculations in complex notation.

$\vec{V_R} = V_R + j0$

$\vec{I} = I \angle -\phi_R = I(\cos\phi_R - j\sin\phi_R)$

$\vec{Z} = R + jX_L$

$\vec{V_S} = \vec{V_R} + \vec{I}\vec{Z}$

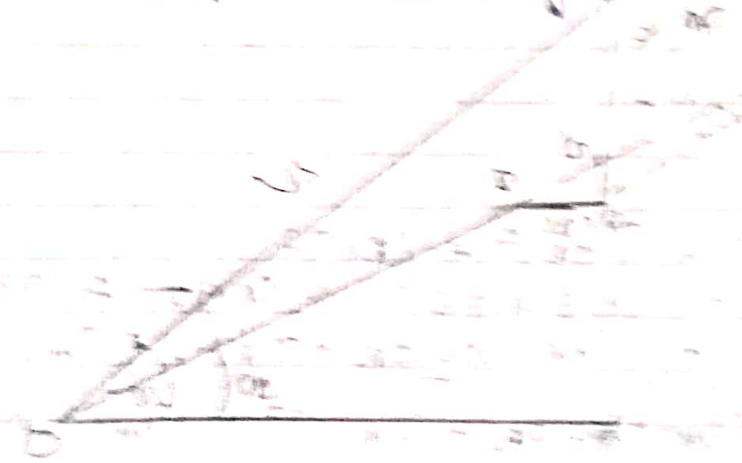
$= (V_R + j0) + I(\cos\phi_R - j\sin\phi_R)(R + jX_L)$

$= (V_R + IR\cos\phi_R + IX_L\sin\phi_R) + j(IX_L\cos\phi_R - IR\sin\phi_R)$

$V_S = \sqrt{(V_R + IR\cos\phi_R + IX_L\sin\phi_R)^2 + (IX_L\cos\phi_R - IR\sin\phi_R)^2}$

$V_S = V_R + IR\cos\phi_R + IX_L\sin\phi_R$

* The solution in complex notation is in more presentable form.



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* The corona affects depends upon the shape and condition of the conductors. the rough and irregular surface will give rise to more corona because unevenness of the surface decrease the value of break down voltage.

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* If the spacing between the conductors is made very large as compared to diameter there may not be any corona

It because, Longer than distance between conductor reduces the electro static stress avoiding corona.

(ii) line voltage:

* The line voltage greatly affects corona. If it is low there is no change in the condition of air surrounding the conductor and hence no corona is formed.

(iii) Disruptive voltage:

* It is the minimum neutral phase voltage at which corona occurs.

$$g = \frac{v}{r \log_e \frac{d}{r}} \ v/cm$$

$$V_C = g_o r \log_e \frac{d}{r} \ v/cm.$$

(iv) Visual critical voltage:

It is the minimum phase - neutral voltage at occurs which the corona was transmission line.

$$V_C = m_o g_o \delta r \left[1 + \frac{0.3}{\delta r}\right] \log_e \frac{d}{r}$$

(v) Power loss due to:-

* Formation of corona always accompained by the electric power which is dissipated from the light heat and sound and chemical action. When disruptive voltage is due to corona as,

$$P = 242.2 \left[\frac{f + 25}{\delta}\right] \sqrt{\frac{r}{d}} (v - v_c)^2 \times 10^{-5}$$

f = frequency in Hz.

DATE / /

Part A:

(1) advantages of bundle conductors:-

* Reactance reduced
* Reduced voltage gradient
* Reduced corona loss
* Reduced ratio interference
* Reduced surge impedence

The reactance of the bundle conductor is reduced because the self GMD of the conductors.

(2)

* Natural of material.
* Diameter of wire = increases with the diameter of wire.
* Frequency = increases with the increases in frequency.
* Shape of wire = less for stranded conductor than the soild conductor.

(3) * when the load p.f is lagging or unity or such leading that IR cos ϕR > IXL then voltage regulation is positive, receiving end voltage VR will be less than the sending end voltages Vs.

* For give VR and I, the voltage regulation of the line increases wi the decreases in pf for lagging loads.

(4) Disadvantages of corona:-

* Corona is accompanied by a loss of energy. This affects the transmission efficiency of the line.

* Ozone is produced by Corona and it Cause Corrosion of the conductor due Chemical action.
* This may Cause Inductive Interference with neighbourhood Communication lines.

(6) * The difference in level between points of supports and the lowest point on the conductor is called sag.
* This is an important consideration in the mechanical design of overhead lines. The conductor sag should be kept a minimum in order to reduce the Conductor material required and to avoid extra pole height for sufficient ground level.

(7) * Rubber
* vulcanised India Rubber (V.I.R)
* Impregnated rubber
* Varnished cambric
* Polyvinyl Chloride (PVC)
* High Insulation resistance to avoid leakage Current.
* Non. inflammable.

(8) * An Underground Cables essentially consists of one or more Conductor Covered with suitable insulation surrounded by a protecting Cover.
* The Cable must be provided with suitable mechanical protection so that it may withstand the rough use in laying it.

(9) Kelvin law of limitation:-

* It is not easy to estimate the energy loss in the line without actual load curves, which are not available at the time of estimations.

* The law does not take into account several physical factors like safe current density mechanical strength, corona loss etc...

* Interest and depreciation on the capital outlay cannot be determined accurately.

(10) advantages of FACTS:-

* The FACTS main objectives of devices is to replace the exciting slow acting mechanical controls required to react to the changing system condition by rather fast acting electronics controls.

* The mechanical control requires power system operation and designers to provide generous margine to assume reliable operation of the system.

$$P = \frac{V_1 V_2}{X} \sin \delta$$

CONTENT BEYOND THE SYLLABUS
EE3401-TRANSMISSION AND DISTRIBUTION

1. Emerging Technologies

- **Smart Grids**
  - Role of IoT, AI, and machine learning in grid management.
  - Self-healing grids and predictive maintenance.
  - Demand response and energy management systems.
- **Microgrids**
  - Design, operation, and challenges of microgrids.
  - Integration with renewable energy sources.
  - Economic and social impact of localized grids.
- **HVDC and FACTS**
  - Advanced HVDC systems: Multi-terminal HVDC.
  - Emerging FACTS devices for improved stability and efficiency.
  - Application of Wide Area Measurement Systems (WAMS).

2. Energy Storage in Transmission and Distribution

- **Battery Energy Storage Systems (BESS)**
  - Role in load balancing and frequency regulation.
  - Case studies: Tesla's Hornsdale Power Reserve.
- **Other Storage Solutions**
  - Flywheels, compressed air, and pumped hydro storage.
  - Integration with renewable energy and grid reliability.

3. Sustainability and Environmental Impact

- **Carbon-neutral Grids**
  - Transition to green energy in transmission systems.
  - Challenges in achieving net-zero emissions.
- **Underground and Undersea Transmission**
  - Environmental benefits and technical challenges.
  - Case studies: Trans-European cables and offshore wind grid connections.

4. Advanced Modeling and Simulation Tools

- Use of PSCAD, PSS/E, or DigSilent PowerFactory, etc.

    - Load flow analysis with renewable integration
    - Fault studies in interconnected networks
    - Dynamic stability analysis
- **Machine Learning for Grid Analytics**
    - Predictive models for fault detection and power flow
    - Optimisation of power dispatch in complex networks

5. Regulatory and Economic Perspectives

- **Energy Markets and Policies**
    - Impact of deregulation on transmission and distribution
    - Case studies on transmission pricing (e.g., Locational Marginal Pricing)
- **Cybersecurity**
    - Threats and mitigation strategies in the power grid
    - Securing SCADA systems and communication networks

6. Case Studies and Industry Practices

- **Large-Scale Transmission Projects**
    - UHVDC projects in China and India
    - Integration of offshore wind power in Europe
- **Innovative Solutions**
    - Flexible AC transmission for integrating renewables
    - Dynamic line rating for maximising existing infrastructure

7. Interdisciplinary Areas

- **Power Electronics in T&D**
    - Application of power electronic converters in renewable integration
    - Solid-state transformers (SSTs) for smart grids
- **Artificial Intelligence Applications**
    - Grid optimization using reinforcement learning
    - Anomaly detection in substations using neural networks

Energy Storage in Transmission and Distribution

Energy storage systems (ESS) play a transformative role in enhancing the efficiency, reliability, and flexibility of transmission and distribution networks. Let's explore this topic in depth:

1. Role of Energy Storage in T&D

Energy storage helps address challenges such as variability in renewable energy generation, peak demand, and grid stability. Key functions include:

- **Load leveling**: Storing excess energy during low demand and releasing it during high demand.
- **Frequency regulation**: Maintaining a stable grid frequency.
- **Voltage support**: Enhancing voltage stability during fluctuations.
- **Renewable integration**: Mitigating the intermittency of solar and wind power.
- **Black start capability**: Providing power to restart the grid after a blackout.

2. Types of Energy Storage Systems in T&D

a) Battery Energy Storage Systems (BESS)

- **Lithium-ion Batteries**: High energy density, suitable for frequency regulation and renewable integration.
- **Flow Batteries**: Long life, used for large-scale grid storage (e.g., Vanadium Redox).
- **Sodium-Sulfur (NaS) Batteries**: High-temperature batteries for grid-scale energy storage.

b) Mechanical Storage

- **Pumped Hydro Storage (PHS)**:
    - The most mature technology.
    - Stores energy by pumping water to a higher elevation during low demand and releasing it to generate power during high demand.
- **Flywheels**:
    - Rotational energy storage for short-duration, high-power applications.
    - Used in frequency regulation and ancillary services.

c) Thermal Energy Storage

- **Molten Salt**:

- Used with concentrated solar power plants.
    - Stores thermal energy for use during non-sunlight hours.
- **Phase Change Materials (PCMs):**
    - Store and release thermal energy through phase transitions.

d) Compressed Air Energy Storage (CAES)

- Stores energy by compressing air in underground caverns during low demand and expanding it to generate power during peak demand.

e) Hydrogen and Power-to-Gas

- Converts excess electricity into hydrogen via electrolysis.
- Hydrogen can be stored and later used in fuel cells or converted back into electricity.

3. Applications of Energy Storage in T&D

1. **Grid Stabilization:**
    - Fast response to grid disturbances (e.g., Lithium-ion for frequency regulation).
    - Smoothing out power fluctuations from renewable sources.
2. **Peak Shaving and Load Shifting:**
    - Reducing the need for peaker plants by meeting peak demand from stored energy.
3. **Transmission and Distribution Deferral:**
    - Avoiding costly upgrades by managing local demand with storage.
4. **Microgrids and Islanding:**
    - Ensuring reliability in isolated grids, especially in disaster-prone areas.
5. **Ancillary Services:**
    - Voltage support, reactive power compensation, and black start.

4. Energy Storage Technologies in Real-World Projects

- **Hornsdale Power Reserve, South Australia:**
    - World's largest lithium-ion battery system.
    - Provides fast frequency response and energy arbitrage services.
- **Pumped Hydro Projects:**
    - Bath County Pumped Storage Station, USA, is the largest pumped hydro facility in the world.
    - Key for grid-scale energy storage in regions with high renewable penetration.
- **Compressed Air in Germany:**
    - The Huntorf CAES plant supports renewable integration and grid reliability.

5. Challenges in Implementing ESS

- **High Costs**: Capital-intensive installation and maintenance.
- **Efficiency Losses**: Round-trip efficiency varies across storage types.
- **Environmental Impact**: Mining for battery materials like lithium and cobalt.
- **Scalability**: Balancing technology capabilities with grid demands.
- **Regulatory Barriers**: Lack of clear policies and incentives for storage deployment.

6. Future Trends

- **Hybrid Systems**:
  - Combining batteries with thermal or mechanical storage for optimized performance.
- **Advanced Materials**:
  - Research into solid-state batteries, graphene supercapacitors, and next-gen flow batteries.
- **AI in Energy Management**:
  - Predictive analytics for storage optimization.
- **Vehicle-to-Grid (V2G)**:
  - Leveraging electric vehicles as a distributed storage resource.
- **Energy-as-a-Service (EaaS)**:
  - Utilities providing storage as a service to customers

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Assignment Question Paper

Name of the Student: EMEE. M

AU Register Number: 732422108001

Assignment – 01				Date of Issue: 10.4.2024	Marks	10
Course code	EE3401	Course Title	Transmission & Distribution			
Year	II	Semester/Section	IV	Date of Submission:	14.4.2024	

Q.No	Questions	CO
1	Explain about Self GMD & Mutual GMD	2
2	Derive the expression for potential at a Conductor in a group of Charged conductors	2
3	Capacitance of a 3-phase OHL	1

K. Vanitha
K. VANITHA
Name and Signature of the Faculty Incharge

HOD/EEE

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Assignment Answer Sheet

Name of the Student: M.EMEE

AU Register Number: 732410E001

Assignment – 1			Date of Issue:	10.4.24	Marks	10
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Mark Allocation

Rubrics	Marks Allocated	Marks obtained
Content Quality	6	6
Presentation Quality	2	2
Timely submission	2	2
Total marks	10	10

K. Vanitha
[K. VANITHA]

Name and Signature of the Faculty Incharge

HOD/EEE

1. Concept of self-GMD and Mutual GMD

(i) self GMD:

* In order to have concept of self-GMD

call means radius.

* Inductance / conductor/m = $2\times10^{-7}\left(\frac{1}{4} + \log_e \frac{d}{r}\right)$

* The radius of this equivalent hollow cylindrical must be sufficiently smaller than the physical radius of the conductor to allow room for enough additional flux to compensate for the absence of internal flux linkage.

Inductance / conductor/m = $2\times10^{-7}\log_e d/D_s$

where D_s = GMR or self-GMD = 0.7788r

(ii) Mutual GMD:

* The mutual-GMD is the geometrical mean of the distance from one conductor to the other and, therefore, must be between the largest and smallest such distance.

* The mutual-GMD between two conductor distance between their centre spacing.

D_m = spacing between conductors and

For a single circuit 3-φ line the mutual GMD is equal to the equivalent equilateral spacing.

$D_m = (d_1 d_2 d_3)^{1/3}$

* Mutual GMD between phases A and B is

$D_{AB} = (D_{ab} \times D_{ab'} \times D_{a'b} \times D_{a'b'})^{1/4}$

* Mutual GMD between phases B and C is

$D_{BC} = (D_{bc} \times D_{bc'} \times D_{b'c} \times D_{b'c'})^{1/4}$

* Mutual GMD between phase C and A is

$D_{CA} = (D_{ca} \times D_{ca'} \times D_{c'a} \times D_{c'a'})^{1/4}$

* Equivalent mutual GMD, $D_m = (D_{AB} \times D_{BC} \times D_{CA})$

(2) Soln:

G.M.R of conductor $= 1.3 \times 0.7788$
$= 1.01$ cm.

Distance a to b' $= \sqrt{6^2 + 3^2} = 6.71$ m

Distance a to a' $= \sqrt{6^2 + 6^2} = 8.48$ m

Equivalent self G.M.D of one phase is,

$D_s = \sqrt[3]{D_{s1} \times D_{s2} \times D_{s3}}$

Now, $D_{s1} = \sqrt[4]{D_{aa} \times D_{aa'} \times D_{a'a'} \times D_{a'a}}$

$= \sqrt[4]{(1.01 \times 10^{-2}) \times (8.48) \times (1.01 \times 10^{-2}) \times (8.48)}$

$= 0.292\ m = D_{s3}$.

$D_{s2} = \sqrt[4]{D_{bb} \times D_{bb'} \times D_{b'b'} \times D_{b'b}}$

$= \sqrt[4]{(1.01 \times 10^{-2}) \times (6) \times (1.01 \times 10^{-2}) \times (6)}$

$= 0.246\ m$.

$D_s = \sqrt[3]{0.292 \times 0.246 \times 0.292}$

$= 0.275\ m$

Equivalent mutual G.M.D. $D_m = \sqrt[3]{D_{AB} \times D_{BC} \times D_{CA}}$.

Now,

$D_{AB} = \sqrt[4]{D_{ab} \times D_{ab'} \times D_{a'b} \times D_{a'b'}}$

$= \sqrt[4]{3 \times 6.7 \times 6.7 \times 3} = 4.48\ m$

$D_{CA} = \sqrt[4]{D_{ca} \times D_{ca'} \times D_{c'a} \times D_{c'a'}}$

$= \sqrt[4]{6 \times 6 \times 6 \times 6} = 6\ m$

$D_m = \sqrt[3]{4.48 \times 4.48 \times 6} = 4.94\ m$.

∴ Inductance per phase,

$$= 10^{-7} \times 2 \log_e \frac{D_m}{D_s}$$

$$= 10^{-7} \times 2 \log_e 4.94 / 0.275$$

$= 5.7 \times 10^{-7}\ H$. $L = 0.57\ mH$.

... of a conductor in a group of charged conductors

Potential at P due to Q_A per charge

$$= \int_{r}^{\infty} \frac{Q_A}{2\pi x \varepsilon_0}\, dx \quad \text{--- (1)}$$

Potential of conductor A due to charge Q_B

$$= \int_{d_1}^{\infty} \frac{Q_B}{2\pi x \varepsilon_0}\, dx \quad \text{--- (2)}$$

Potential of conductor A due to charge Q_C

$$= \int_{d_2}^{\infty} \frac{Q_C}{2\pi x \varepsilon_0}\, dx \quad \text{--- (3)}$$

Overall potential difference

$$V_A = (1) + (2) + (3)$$

$$= \int_{r}^{\infty} \frac{Q_A}{2\pi x \varepsilon_0}\, dx + \int_{d_1}^{\infty} \frac{Q_B}{2\pi x \varepsilon_0}\, dx + \int_{d_2}^{\infty} \frac{Q_C}{2\pi x \varepsilon_0}\, dx + \dots$$

$$= \frac{1}{2\pi\varepsilon_0}\left[Q_A(\log_e \infty - \log_e r) + Q_B(\log_e \infty - \log_e d_1) + Q_C(\log_e \infty - \log_e d_2)\right]$$

$$= \frac{1}{2\pi\varepsilon_0}\left[Q_A \log_e \frac{1}{r} + Q_B \log_e \frac{1}{d_1} + Q_C \log_e \frac{1}{d_2} + \log_e \infty (Q_A + Q_B + Q_C) + \dots\right]$$

Assuming balanced condition,

$$V_A = \frac{1}{2\pi\varepsilon_0}\left[Q_A \log_e \frac{1}{r} + Q_B \log_e \frac{1}{d_1} + Q_C \log_e \frac{1}{d_2}\right]$$

Capacitance of a 3-phase overhead line

In symmetrical spacing:

The three conductors A, B and C of the 3-phase overhead transmission line having charges Q_A, Q_B and Q_C per metre length respectively, the conductors be equidistant from each other. We shall find the capacitance from line conductor ...

$$V_A = \int_{r}^{\infty} \frac{Q_A}{2\pi x \varepsilon_0}\, dx + \int_{d}^{\infty} \frac{Q_B}{2\pi x \varepsilon_0}\, dx + \int_{d}^{\infty} \frac{Q_C}{2\pi x \varepsilon_0}\, dx$$

$$= \frac{1}{2\pi\varepsilon_0}\left[Q_A \log_e \frac{1}{r} + Q_B \log_e \frac{1}{d} + \dots\right]$$

$$= \frac{1}{2\pi\varepsilon_0}\left[Q_A \log_e \frac{1}{r} + (Q_B + Q_C) \log_e \frac{1}{d}\right]$$

We have, $Q_A + Q_B + Q_C = 0$

$Q_B + Q_C = -Q_A$

$Q_b + Q_c = -Q_a$

$$V_a = \frac{1}{2\pi\epsilon_0}\left[Q_a \log_e \frac{1}{r} - Q_a \log_e \frac{1}{d}\right]$$

$$V_a = \frac{Q_a}{2\pi\epsilon_0} \log_e \frac{d}{r} \text{ volts}$$

Capacitance of conductor a to neutral

$$C_a = \frac{Q_a}{V_a} = \frac{Q_a}{\frac{Q_a}{2\pi\epsilon_0} \log_e \frac{d}{r}} \text{ F/m}$$

$$\boxed{C_a = \frac{2\pi\epsilon_0}{\log_e \frac{d}{r}} \text{ F/m}}$$

(iii) Unsymmetrical spacing -

* The 3-phase transposed line having unsymmetrical spacing.

$$V_1 = \frac{1}{2\pi\epsilon_0}\left[Q_a \log_e \frac{1}{r} + Q_b \log_e \frac{1}{d_3} + Q_c \log_e \frac{1}{d_2}\right]$$

$$V_2 = \frac{1}{2\pi\epsilon_0}\left[Q_a \log_e \frac{1}{r} + Q_b \log_e \frac{1}{d_1} + Q_c \log_e \frac{1}{d_3}\right]$$

$$V_3 = \frac{1}{2\pi\epsilon_0}\left[Q_a \log_e \frac{1}{r} + Q_b \log_e \frac{1}{d_2} + Q_c \log_e \frac{1}{d_1}\right]$$

$$V_a = \frac{1}{3}(V_1 + V_2 + V_3)$$

$$V_a = \frac{Q_a}{2\pi\epsilon_0} \log_e \frac{d_1 d_2 d_3}{r^3}$$

$$= \frac{1}{3} \times \frac{Q_a}{2\pi\epsilon_0} \log_e \frac{d_1 d_2 d_3}{r^3}$$

$$= \frac{Q_a}{2\pi\epsilon_0} \log_e \frac{(d_1 d_2 d_3)^{1/3}}{r^{3/3}}$$

$$= \frac{Q_a}{2\pi\epsilon_0} \log_e \frac{(d_1 d_2 d_3)^{1/3}}{r}$$

Capacitance from conductor to neutral is

$$C_n = \frac{Q_a}{V_a} = \frac{2\pi\epsilon_0}{\log_e \frac{\sqrt[3]{d_1 d_2 d_3}}{r}} \text{ F/m}$$

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Assignment Question Paper

Name of the Student: M. EMEE

AU Register Number: 732422105001

Assignment – 01			Date of Issue:	18. 5. 2024	Marks	10
Course code	EE 3401	Course Title	Transmission & Distribution			
Year	II	Semester/Section	IV	Date of Submission:	26.5.2024	

Q.No	Questions	CO
1	Explain about Corona	Co3
2	What are the Factor affecting corana	Co3
3	Paoblem in Corona	

K. Vanitha
K. VANITHA

Name and Signature of the Faculty Incharge

HOD/EEE

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Assignment Answer Sheet

A.

Name of the Student: M.EMEE

AU Register Number: 732422105001

Assignment – 02			Date of Issue:	18.5.2024	Marks	10
Course code	EE3401	Course Title	Transmission & Distribution			
Year	II	Semester/Section	IV	Date of Submission:	26.5.2024	

Q.No	Questions	CO
1	Explain about corona	3
2	What are the factors affecting Corona	3
3	Problem in Corona	

Mark Allocation

Rubrics	Marks Allocated	Marks obtained
Content Quality	6	6
Presentation Quality	2	2
Timely submission	2	2
Total marks	10	10

K.Vanitha
K.VANITHA

Name and Signature of the Faculty Incharge

HOD/EEE

I) Corona:

* when an alternating potential difference is applied across two conductors whose spacing is large as compared to their diameters, there is no apparent change in the condition of atmospheric air surronding the wires if the applied voltage is low.

* The phenomenon of corona is accompained by a hissing sound. production of ozone, power loss and radio interference.

* The phenomenon of violet glow. hissing noise and Production of ozone gas in an overhead transmission line is known as Corona.

Factors Affecting Corona:

i) Atmosphere:

* As corona is formed due to ionsiation of air surrounding the Conductors, therefore, it is affected by the physical state of atmosphere. In the stomy wheather.

ii) Conductor Size:-

* The corona effect depends upon the shape and condition of the conductor. the rough and

Irregular surface will give rise to more corona because unevenness of the surface decreases the value of breakdown voltage.

(ii) Spacing between conductors:

* If the spacing between the conductors is made very large as compared to their diameter, there may not be any corona effect.

(iii) Line voltage:

* The line voltage greatly affects corona. If it is low, there is no change in the condition of air surrounding the conductor and hence no corona is formed.

Important terms:

(i) Critical disruptive voltage:

It is the minimum phase-neutral voltage at which corona occurs.

$$g = \frac{V}{r \log_e \frac{d}{r}} \text{ volts/cm}$$

$$g_o = \frac{V_c}{r \log_e \frac{d}{r}}$$

Critical disruptive voltage, $V_c = g_o r \log_e \frac{d}{r}$

(ii) Visual critical voltage:

It is the minimum phase-neutral voltage at which corona glow appears all along the line conductors.

$$V_v = m_v g_o \delta r \left(1 + \frac{0.3}{\sqrt{\delta r}}\right) \log_e \frac{d}{r} \text{ kV/phase}$$

(iii) Power loss due to corona:

Formation of corona is always accompanied by energy loss which is dissipated i[n] the form of light, heat, sound and chemical action. When disruptive voltage is exceeded, the power loss due to corona is by.

$$P = 242.2 \left[\frac{f+25}{\delta}\right] \sqrt{\frac{r}{d}} (V - V_c)^2 \times 10^{-5} \text{ kW/ph[ase]}$$

Advantages:

* Due to corona formation, the air su[rrounding] the conductor becomes conducting and h[ence] virtual diameter of the conductor is [increased]. The increased diameter reduces the diele[ctric] stresses between the conductors.

* Corona reduces the effects of tra[nsients] produced by surges.

Disadvantages:

- Corona is accompanied by a loss of energy. This affects the transmission efficiency of the line.
- Ozone is produced by corona and may cause corrosion of the conductor due to chemical action.
- This may cause inductive interference with neighbouring communication lines.

Methods of corona effects:

i) By increasing conductor size:

- By increasing conductor size, the voltage at which corona occurs is raised and hence corona effects are considerably reduced. This is one of the reasons that ACSR conductors which have a larger cross sectional area are used in transmission lines.

ii) By increasing conductor spacing:

By increasing the spacing between conductors, the voltage at which corona occurs is raised and hence corona effects can be eliminated. However, spacing cannot be increased too much otherwise the cost of supporting structure may increase to a considerable extent.

(2) Sol:

Assume the line is 3-phase

Conductor radius $r = 1.956/2 = 0.978$ cm

Dielectric strength of air, $g_0 = \frac{30}{\sqrt{2}}$

$= 21.2$ kV per cm

Disruptive voltage/phase, $V_c = \frac{210}{\sqrt{3}}$

$= 121.25$ kV

∴ Disruptive voltage (r.m.s) per phase is,

$V_c = m_0 g_0 \delta r \log_e (d/r)$ kV

$= 1 \times 21.2 \times 1 \times 0.978 \times \log_e (d/r)$

$121.25 = 20.733 \log_e (d/r)$

$\log_e \frac{d}{r} = \frac{121.25}{20.733} = 5.848$

$2.3 \log_{10} d/r = 5.848$

$\log_{10} d/r = 5.848/2.3$

$= 2.5426$

$d/r = \text{Antilog } 2.5...$

$d/r = 348.8$

Conductor spacing, $d = 348.8 \times ...$

362.3 × 0.978 = 354 cm

∴ Conductor spacing, d = [illegible] cm

(3) Solu:

As seen from art. 8.12 the corona loss is given by

$$P = \frac{242.2}{\delta}(f+25)\sqrt{\frac{r}{d}}(V-V_c)^2 \times 10^{-5} \text{ kW}$$

$$\delta = \frac{3.92b}{273+t} = \frac{3.92 \times 76}{273+40} = 0.952.$$

$g_0 = 21.2$ kV.

∴ critical disruptive voltage per phase is,

$$V_c = m_0 g_0 \delta r \log_e d/r \text{ kV}$$

$$= 0.85 \times 21.2 \times 0.952 \times 1.5 \times \log_e 200/1.5$$

$$= 125.9 \text{ kV}$$

Supply voltage per phase, $V = \frac{200}{\sqrt{3}}$

$= 127$ kV

we have corona loss as:

$$P = \frac{242.2}{0.952}(50+25) \times \sqrt{\frac{1.5}{200}} \times (127-125.9)^2 \times 10^{-5} \text{ kW}$$

$$= \frac{242.2}{0.952} \times 75 \times 0.0866 \times 1.21 \times 10^{-5} \text{ kW}$$

$= 0.01999$ kW

∴ total corona loss = 3 × 0.01999 kW

$= 0.05998$ kW.

Transmission and Distribution

Unit I

1. List out the practical transmission and distribution voltage levels commonly used.

Primary transmission: 110KV/132KV/220KV/400KV/765KV
Secondary transmission: 66KV/33KV
Primary distribution: 11KV/6.6KV
Secondary distribution: 400V for 3φ; 230V for 1φ

2. What is an electrical power supply system?
The flow of electrical power from the generating station to the consumer is called an electrical power system or electrical power supply system. The generation, transmission and distribution of electrical power supply system.

3. Explain the term regional grid.
The interconnection transmission system of a state or a region is called the grid of state or region. State grids are interconnected with the help of tie lines and form the regional grid.

4. What is bulk supply system?
The generating voltages (11KV or 33KV) are stepped up by using generating transformer connected to generators and transmission lines, to avoid heating and insulating problems. The generating and transmission systems are called as bulk supply system.

5. What is the function of transmission system?
The transmission system is to deliver bulk power from the power station to load center and large industrial consumers.

6. Specify the allowable voltage variation tolerance in EHV A.C transmission.
±5 to ±10%

7. Mention the need of going for EHV A.C transmission.

- EHV transmissions provide more reliable and less constrained electricity network capacity.
- As the size of the generating unit increases due to increase in voltage, the cost of the line decreases.
- Transmission efficiency increases.
- Number of circuits and land requirements for transmission decreases.
- Cost of the line decreases.
- Surge impedance loading increases.

7. What is the effect of high voltage on volume of copper?
Volume α $1/VL^2 \cos^2\varphi$
As the voltage increases, volume of conductor decreases. So the cost of the conductor decreases.

9. What are the limitations of EHV A.C transmission?

- More insulation is required for the conductors and towers.

- More clearance is required between the conductors. So the length of cross arm increases.
- The transformers, switchgears and other terminal equipments should be designed to handle such high voltage.
- Long distance bulk power transmission not possible.

9. What is the highest A.C transmission we have in India?
765KV

11. What are the advantages of EHV A.C transmission?
    - Reduction of current and losses.
    - Reduction of volume of conductor material.
    - Improvement in voltage regulation.
    - Increase in transmission efficiency.
    - Reduction in % line drop.

12. What are various types of HVDC transmission systems?
    - Monopolar HVDC transmission system.
    - Bipolar HVDC transmission system.
    - Homopolar HVDC transmission system.

13. What are the advantages of HVDC transmission system?
    - HVDC can carry more power with two conductors.
    - Corona loss and radio interference is less.
    - Dielectric loss is less.
    - Absence of skin effect, reduce power losses.
    - Ground can be used as return conductor.
    - Economical for long distance transmission.
    - No charging current.
    - No transmission of short circuit power in case of any fault.
    - Fault clearing time is small.
    - Does not require line compensation.
    - Asynchronous interconnection of A.C system operating at different frequencies.
    - Control and stabilization of power flow in A.C ties in an integrated power system.
    - No reactive power loss.

13. What are the disadvantages of HVDC transmission system?
    - Terminal equipment cost is high due to presence of converters and filters.
    - Maintenance cost is high.
    - Cost of D.C breakers is high.
    - Inability to use transformers to change voltage levels.
    - Converters generate harmonics both on A.C and D.C sides. These harmonics may interfere with communication systems.
    - D.C lines block the flow of reactive power from one end to another end. But these are required by some load that must be fulfilled by the inverters.
    - Point to point transmission is not possible by HVDC.

Reg. No. :

Question Paper Code : 50534

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2022

Fourth Semester

Electrical and Electronics Engineering

EE 8402 — TRANSMISSION AND DISTRIBUTION

(Regulations 2017)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the effect of bundled conductors on line inductance?

2. What is proximity effect?

3. For a lossless transmission line $L = 0.001\ mH/m$, $C = 10\ pF/m$ and frequency = 50 Hz. Find the value of attenuation constant.

4. What are the factors which affect corona loss?

5. What is the effect of wind on sag?

6. What are the important factory tests conducted on insulators?

7. Define capacitance grading of cables.

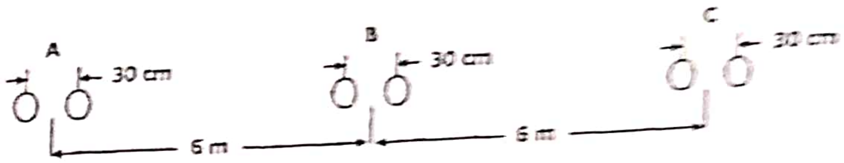
8. What are oil filled cables?

9. What is Kelvin's law for most economic size of the line conductor?

10. What is the role of the load power factor in the AC distribution system?

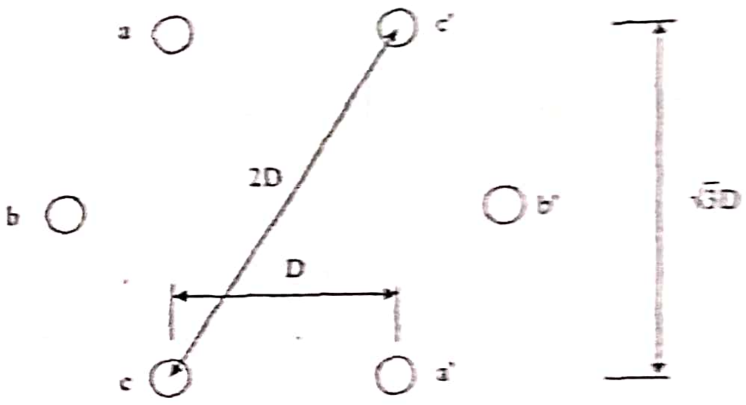
PART B — (5 × 13 = 65 marks)

11. (a) Calculate the inductance per km per phase for a 3-phase, 50 Hz, bundled conductor line shown in Figure. Each subconductor has a diameter of 25 mm and subconductor spacing is 0.3 m. Assume that each phase group shares total current and charge equally and the line is completely transposed.



Or

(b) A 3-phase double circuit line has the conductors at the vertices of a hexagon as shown in Figure. Find the formula for calculating capacitance per phase per km in terms of side D and conductor radius r.



12. (a) A 3-phase, 50 Hz, 16 km long overhead line supplies 1000 kW at 11kV, 0.8 p.f. lagging. The line resistance is 0.03 Ω per phase per km and line inductance is 0.7 mH per phase per km. Calculate the sending end voltage, voltage regulation and efficiency of transmission.

Or

(b) Draw the phasor diagram for a nominal π circuit and derive the expressions for sending end voltage and current in terms of receiving end voltage and current.

13. (a) An overhead line has a span of 336 m. The line is supported at a water crossing, from two towers whose heights are 33.6 m and 29 m above water level. The weight of conductor is 8.33 kg/m and tension in the conductor is not to exceed 33400 N. Find clearance between the lowest point on the conductor and water and also find the horizontal distance of this point from the lower support.

Or

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

14. (a) Draw the cross-section of a 3-core belted cable. Discuss the function of each part.

Or

(b) Derive a relation between the conductor radius and inside sheath radius of a single core cable so that the electric stress of the conductor surface may be minimum.

15. (a) Discuss about the different techniques of voltage control.

Or

(b) Discuss the technical and economic advantages of HVDC systems over HVAC systems.

PART C — (1 × 15 = 15 marks)

16. (a) A 3-phase overhead line has a series impedance of 10 + j30 ohms per phase. For receiving and sending end voltages of 132 kV and 140 kV respectively draw the receiving end power circle and determine the maximum real power which the line can supply and the load power factor for drawing this maximum power.

Or

(b) Two conductors of a DC distributor cable AB 1000m long have a total resistance of 0.1 Ω. The ends A and B are fed at 240 V. The cable is uniformly loaded at 0.5 A per metre length and has concentrated loads of 120 A, 60 A, 100 A and 40 A at points distant 200 m, 400 m, 700 m and 900 m respectively from the end A. Calculate the point of minimum potential and the value of minimum potential.
