



Department of Electrical and Electronic Engineering

Level-~~4~~<sup>3</sup>, Term-~~II~~<sup>I</sup>

Mid Term Examination, Spring 2023

Course Code: EEE-307

Course Title: Power System I

Time: 1 hr

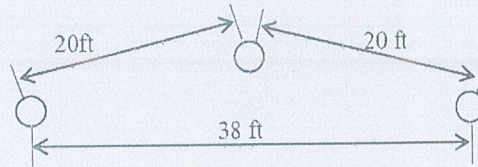
Full Marks: 60

Notes:

- Each question carries 30 marks.
- Figure on the right of each question indicate marks for respective question.
- Answer any two questions including question no 1.

1 a. What type of conductor we use in electrical power transmission line? Mention some advantages of using composite conductor. [6]

b. A three phase line operated at 60 Hz is arranged as shown. The conductors are ACSR Merlin. Find the inductive reactance per mile. [9]



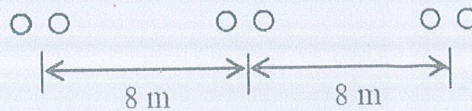
[15]

c. 75 km long transmission line supplies a load of 5 MVA at 0.78 p.f. lagging at 33 kV. The efficiency of transmission is 86%. Calculate the volume of aluminium conductor required for the line when 3-phase, 3-wire system is used. The specific resistance of aluminium is  $2.75 \times 10^{-8} \Omega\text{m}$ .

2 a. Mention the names of different types of Aluminum conductors. [6]

b. If each conductor of the bundled conductor line shown in the figure is 1272 MCM Pheasant. Find: [24]

- the inductive reactance in  $\Omega/\text{km}$  and  $\Omega/\text{mile}$  per phase for  $d = 50 \text{ cm}$
- the p.u. series reactance if the length of the line is 160 km and the base is 100 MVA, 345 kV.



3 a. Define with mathematical expression : [10]

- Critical disruptive voltage
- Visual critical voltage [12]

b. With the help of a diagram(s) describe Skin Effect of transmission line. Which factor(s) can effect skin effect? [8]

c. Why we need to use Corona Ring? [8]

Necessary Attachment :

TABLE-A.3: Electrical characteristics of bare aluminum conductors steel-reinforced (ACSR)\*

TABLE-A.4: Inductive reactance spacing factor  $X_d$  at 60 Hz\*

The End

Attachment : TABLE-1: Electrical characteristics of bare aluminum conductors steel-reinforced (ACSR)\*

TABLE A.3  
Electrical characteristics of bare aluminum conductors steel-reinforced (ACSR) \*

Code word	Aluminum area, cmil	Stranding Al/St	Layers of aluminum	Outside diameter, in	Dc, 20°C, Ω/1,000ft	Resistance		GMR D <sub>s</sub> ft	Reactance per conductor 1-ft spacing, 60 Hz	
						Ac, 60 Hz			Inductive X <sub>a</sub> , Ω/mi	Capacitive X <sub>a</sub> , MΩ.mi
						20°C, Ω/mi	50°C, Ω/mi			
Waxwing	266.800	18/1	2	0.609	0.0646	0.3488	0.3831	0.0198	0.476	0.1090
Partridge	266.800	26/7	2	0.642	0.0640	0.3452	0.3792	0.0217	0.465	0.1074
Ostrich	300.000	26/7	2	0.680	0.0569	0.3070	0.3372	0.0229	0.458	0.1057
Merlin	336.400	18/1	2	0.684	0.0512	0.2767	0.3037	0.0222	0.462	0.1055
Linnet	336.400	26/7	2	0.721	0.0507	0.2737	0.3006	0.0243	0.451	0.1040
Oriole	336.400	30/7	2	0.741	0.0504	0.2719	0.2987	0.0255	0.445	0.1032
Chickadee	397.500	18/1	2	0.743	0.0433	0.2342	0.2572	0.0241	0.452	0.1031
Ibis	397.500	26/7	2	0.783	0.0430	0.2323	0.2551	0.0264	0.441	0.1015
Pelican	477.000	18/1	2	0.814	0.0361	0.1957	0.2148	0.0264	0.441	0.1004
Flicker	477.000	24/7	2	0.846	0.0359	0.1943	0.2134	0.0284	0.432	0.0992
Hawk	477.000	26/7	2	0.858	0.0357	0.1931	0.2120	0.0289	0.430	0.0988
Hen	477.000	30/7	2	0.883	0.0355	0.1919	0.2107	0.0304	0.424	0.0980
Osprey	556.500	18/1	2	0.879	0.0309	0.1679	0.1843	0.0284	0.432	0.0981
Parakeet	556.500	24/7	2	0.914	0.0308	0.1669	0.1832	0.0306	0.423	0.0969
Dove	556.500	26/7	2	0.927	0.0307	0.1663	0.1826	0.0314	0.420	0.0965
Rook	636.000	24/7	2	0.977	0.0269	0.1461	0.1603	0.0327	0.415	0.0950
Grosbeak	636.000	26/7	2	0.990	0.0268	0.1454	0.1596	0.0335	0.412	0.0946
Drake	795.000	26/7	2	1.108	0.0215	0.1172	0.1284	0.0373	0.399	0.0912
Tern	795.000	45/7	3	1.063	0.0217	0.1188	0.1302	0.0352	0.406	0.0925
Rail	954.000	45/7	3	1.165	0.0181	0.0997	0.1092	0.0386	0.395	0.0897
Cardinal	954.000	54/7	3	1.196	0.0180	0.0988	0.1082	0.0402	0.390	0.0880
Ortolan	1.033.500	45/7	3	1.213	0.0167	0.0924	0.1011	0.0402	0.390	0.0885
Bluejay	1.113.000	45/7	3	1.259	0.0155	0.0861	0.0941	0.0415	0.386	0.0874
Finch	1.113.000	54/19	3	1.293	0.0155	0.0856	0.0937	0.0436	0.380	0.0866
Bittern	1.272.000	45/7	3	1.345	0.0136	0.0762	0.0832	0.0444	0.378	0.0855
Pheasant	1.272.000	54/19	3	1.382	0.0135	0.0751	0.0821	0.0466	0.372	0.0847
Bobolink	1.431.000	45/7	3	1.427	0.0121	0.0684	0.0746	0.0470	0.371	0.0837
Plover	1.431.000	54/19	3	1.465	0.0120	0.0673	0.0735	0.0494	0.365	0.0829
Lapwing	1.590.000	45/7	3	1.502	0.0109	0.0623	0.0678	0.0498	0.364	0.0822
Falcon	1.590.000	54/19	3	1.545	0.0108	0.0612	0.0667	0.0523	0.358	0.0814
Bluebird	2.156.000	84/19	4	1.762	0.0080	0.0476	0.0515	0.0586	0.344	0.0776

\* Most used multilayer sizes.

\*\* Data, by permission, from Aluminum Association, Aluminum Electrical Conductor Handbook, 2<sup>nd</sup> ed., Washington, D.C., 1982.

Copiado de: J.J.Grainger, W.D.Stevenson, Power System Analysis, McGraw-Hill, 1994.

Attachment : TABLE-2: Inductive reactance spacing factor X<sub>d</sub> at 60 Hz\*

TABLE A.4 Inductive reactance spacing factor X<sub>d</sub> at 60 Hz\* (ohms per mile per conductor)

Feet	Separation Inches											
	0	1	2	3	4	5	6	7	8	9	10	11
0	.....	-0,3015	-0,2174	-0,1682	-0,1333	-0,1062	-0,0841	-0,0654	-0,0492	-0,0349	-0,0221	-0,0106
1	0,0000	0,0097	0,0187	0,0271	0,0349	0,0423	0,0492	0,0558	0,0620	0,0679	0,0735	0,0789
2	0,0841	0,0891	0,0938	0,0984	0,1028	0,1071	0,1112	0,1152	0,1190	0,1227	0,1264	0,1299
3	0,1333	0,1366	0,1399	0,1430	0,1461	0,1491	0,1520	0,1549	0,1577	0,1604	0,1631	0,1657
4	0,1682	0,1707	0,1732	0,1756	0,1779	0,1802	0,1825	0,1847	0,1869	0,1891	0,1912	0,1933
5	0,1953	0,1973	0,1993	0,2012	0,2031	0,2050	0,2069	0,2087	0,2105	0,2123	0,2140	0,2157
6	0,2174	0,2191	0,2207	0,2224	0,2240	0,2256	0,2271	0,2287	0,2302	0,2317	0,2332	0,2347
7	0,2361	0,2376	0,2390	0,2404	0,2418	0,2431	0,2445	0,2458	0,2472	0,2485	0,2498	0,2511
8	0,2523											
9	0,2666											
10	0,2794											
11	0,2910											
12	0,3015											
13	0,3112											
14	0,3202											
15	0,3286											
16	0,3364											
17	0,3438											
18	0,3507											
19	0,3573											
20	0,3635											
21	0,3694											
22	0,3751											
23	0,3805											
24	0,3856											
25	0,3906											
26	0,3953											
27	0,3999											
28	0,4043											
29	0,4086											
30	0,4127											
31	0,4167											
32	0,4205											
33	0,4243											
34	0,4279											
35	0,4314											
36	0,4348											

At 60 Hz, in Ω/mi per conductor  
 $X_d = 0.2794 \log d$   
 d= separation, ft  
 For three-phase lines  
 $d = Deq$

Copiado de: J.J.Grainger, W.D.Stevenson, Power System Analysis, McGraw-Hill, 1994.