MFUEC051

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LNMIIT/B. Tech./ECE/2019-20/EVEN/ECE3021/MT

The LNM Institute of Information Technology

Department: Electronics and Communication Engineering

Electrical Machines and Power Systems (ECE3021)

Exam Type: Mid Term

Time: 90 minutes **Date: February 24, 2020** **Max. Marks: 30**

Instructions:

1. *The Question Paper has TWO PAGES.*
2. *All the questions are compulsory and are worth 5 marks each.*

Q.1 A. Show that 1 KWh of energy is equivalent to 3.6 MJoules of energy. B. A 500-V D.C. source is connected across the two terminals of a 20-ohm resistive load. How much energy would the load consume over a continuous 24-hour period? C. Repeat B by replacing the source with a 220-V, 50-Hz A.C. source. D. Repeat B by replacing the load with a series R-L circuit containing R = 20 ohm and L = 3 millihenry. E. Repeat B by replacing the load with a series R-L-C circuit containing R = 50 ohm, L = 1 millihenry, and C = 3 millifarad.

Q.2 A. What are the main advantages and disadvantages of a Three-Phase Power System over a Single-Phase Power System? B. Rigorously show that, in a balanced Wye-Wye Power System, the current flowing in neutral wire is zero. C. Rigorously show that, in a balanced Wye-Wye Power System, the instantaneous power, at both generator and load ends, has no time-dependent component.

Q. 3 Derive the equations for converting an unbalanced delta-load into an equivalent star-load, and vice-versa.

Q. 4 Consider a balanced Y-Y power system with positive phase sequence and line voltage magnitude = 13.8 KV (R.M.S.). The transmission lines have negligible impedance. The neutral wire has negligible impedance, too. Each branch of the load contains a single 1.5 Kohm resistor. Calculate a) the phasor expressions for the three phase voltages, b) the phasor expressions for the three phase currents, c) the phasor expressions for the three line currents, d) the total complex power generated, and e) the total complex power in load.

Q. 5 A. How many turns must the primary and secondary windings of a 220-V/110-V, 60-Hz, ideal transformer have if the core flux density is not allowed to exceed 0.50 Tesla? Assume that the area of cross-section of this transformer's core is equal to 100 square centimeters. Note that 1 Tesla is defined to be equal to 1 Weber per square meter. B. For the non-ideal transformer schematically depicted in Figure 5B, calculate i) the input impedance (that is, the impedance seen between the two terminals of the voltage source), ii) the primary current, iii) the secondary current, iv) the AWG wire size for the primary winding, v) the AWG wire size for the secondary winding, and vi) the voltage seen across the two terminals of the capacitor. Assume that the frequency of operation is 50 Hz.

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Q. 6 A. Derive the condition for maximum efficiency in a typical voltage transformer. Clearly state the assumptions made.

B. A 2200/220 V, 4.4 KVA, 50 Hz voltage transformer operates over a full 24-hour time-period, as follows: i) 8 AM to 8 PM, full-load with 0.8 power factor, ii) 8 PM to midnight, ¼ load with 0.9 power factor, and iii) Midnight to 8 AM, no-load. The iron loss in this transformer is equal to 250 Watts. The full-load copper loss of this transformer is equal to 1250 Watts. Calculate the all-day efficiency of the transformer.

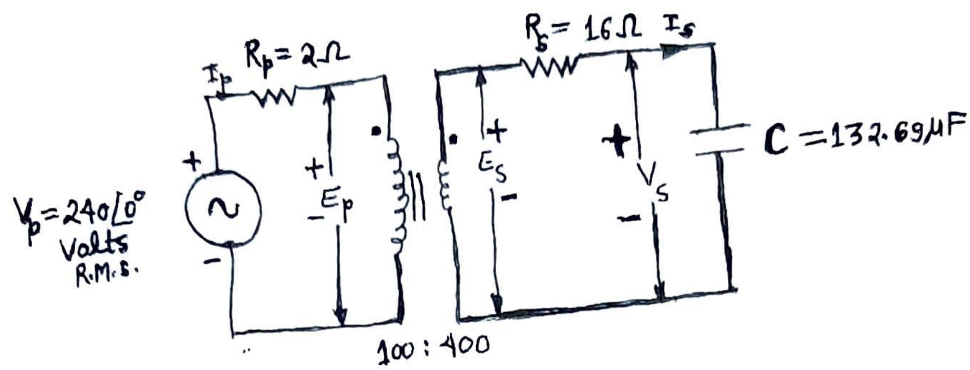

FIGURE 5B

Table 1: American Wire Gauge (AWG) Cable / Conductor Sizes and Properties

AWG	Diameter [inches]	Diameter [mm]	Area [mm²]	Resistance [Ohms / 1000 ft]	Resistance [Ohms / km]	Max Current [Amperes]	Max Frequency for 100% skin depth
0000 (4/0)	0.46	11.684	107	0.049	0.16072	302	125 Hz
000 (3/0)	0.4096	10.40384	85	0.0618	0.202704	239	160 Hz
00 (2/0)	0.3648	9.26592	67.4	0.0779	0.255512	190	200 Hz
0 (1/0)	0.3249	8.25246	53.5	0.0983	0.322424	150	250 Hz
1	0.2893	7.34822	42.4	0.1239	0.406392	119	325 Hz
2	0.2576	6.54304	33.6	0.1563	0.512664	94	410 Hz
3	0.2294	5.82676	26.7	0.197	0.64616	75	500 Hz
4	0.2043	5.18922	21.2	0.2485	0.81508	60	650 Hz
5	0.1819	4.62026	16.8	0.3133	1.027624	47	810 Hz
6	0.162	4.1148	13.3	0.3951	1.295928	37	1100 Hz
7	0.1443	3.66522	10.5	0.4982	1.634096	30	1300 Hz
8	0.1285	3.2639	8.37	0.6282	2.060496	24	1650 Hz
9	0.1144	2.90576	6.63	0.7921	2.598088	19	2050 Hz
10	0.1019	2.58826	5.26	0.9989	3.276392	15	2600 Hz
11	0.0907	2.30378	4.17	1.26	4.1328	12	3200 Hz
12	0.0808	2.05232	3.31	1.588	5.20864	9.3	4150 Hz
13	0.072	1.8288	2.62	2.003	6.56984	7.4	5300 Hz
14	0.0641	1.62814	2.08	2.525	8.282	5.9	6700 Hz
15	0.0571	1.45034	1.65	3.184	10.44352	4.7	8250 Hz
16	0.0508	1.29032	1.31	4.016	13.17248	3.7	11 k Hz
17	0.0453	1.15062	1.04	5.064	16.60992	2.9	13 k Hz
18	0.0403	1.02362	0.823	6.385	20.9428	2.3	17 kHz
19	0.0359	0.91186	0.653	8.051	26.40728	1.8	21 kHz
20	0.032	0.8128	0.518	10.15	33.292	1.5	27 kHz
21	0.0285	0.7239	0.41	12.8	41.984	1.2	33 kHz
22	0.0254	0.64516	0.326	16.14	52.9392	0.92	42 kHz
23	0.0226	0.57404	0.258	20.36	66.7808	0.729	53 kHz
24	0.0201	0.51054	0.205	25.67	84.1976	0.577	68 kHz
25	0.0179	0.45466	0.162	32.37	106.1736	0.457	85 kHz
26	0.0159	0.40386	0.129	40.81	133.8568	0.361	107 kHz
27	0.0142	0.36068	0.102	51.47	168.8216	0.288	130 kHz
28	0.0126	0.32004	0.081	64.9	212.872	0.226	170 kHz
29	0.0113	0.28702	0.0642	81.83	268.4024	0.182	210 kHz
30	0.01	0.254	0.0509	103.2	338.496	0.142	270 kHz
31	0.0089	0.22606	0.0404	130.1	426.728	0.113	340 kHz
32	0.008	0.2032	0.032	164.1	538.248	0.091	430 kHz
33	0.0071	0.18034	0.0254	206.9	678.632	0.072	540 kHz
34	0.0063	0.16002	0.0201	260.9	855.752	0.056	690 kHz
35	0.0056	0.14224	0.016	329	1079.12	0.044	870 kHz
36	0.005	0.127	0.0127	414.8	1360	0.035	1100 kHz
37	0.0045	0.1143	0.01	523.1	1715	0.0289	1350 kHz
38	0.004	0.1016	0.00797	659.6	2163	0.0228	1750 kHz
39	0.0035	0.0889	0.00632	831.8	2728	0.0175	2250 kHz
40	0.0031	0.07874	0.00501	1049	3440	0.0137	2900 kHz