

ELECTRICAL MACHINES AND POWER SYSTEMS

Mid Term Examination, 29th September 2018 (11:30 AM to 01:00 PM)

Duration: 90 minutes

Max. Marks: 30

NOTE: You are allowed to bring one A4 size formula sheet to the Examination Hall.

1. What are the main advantages and disadvantages of three-phase power systems over single-phase power systems? Mathematically show that the neutral current in a balanced Y-Y power system is zero. Make suitable assumptions if necessary. State the assumptions made. [5]
2. A single-phase (1- ϕ) a.c. voltage $v(t) = 311.13 \cos(314t + 37^\circ)$ volts is applied across a load containing a $50\text{-}\Omega$ resistor in series with a 200 mH inductor and a $50\text{ }\mu\text{F}$ capacitor. Compute the approximate numerical value of the power-factor angle and the power-factor. Is the power-factor leading or lagging? Also sketch the power triangle. [5]
3. For the three-phase power system shown in FIGURE 3, calculate line currents I_a , I_b , and I_c . Also sketch the power triangle. Assume that all the given voltage values are RMS values. [5]

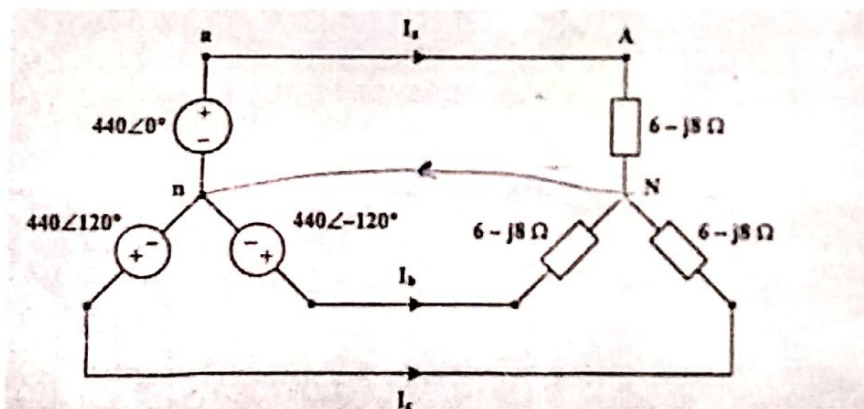


FIGURE 3

4. A balanced three-phase star-connected load has one $10\text{ }\mu\text{F}$ capacitor in each of its three branches. Sketch the delta-equivalence of this load and show all element values. [5]
5. A. The nameplate of the electrical transformer shown in FIGURE 5A reads 33-KVA, 3300/110-V, 50-Hz. Calculate the turns-ratio of the transformer. What AWG size wires, in your humble opinion, are being used for primary and secondary windings? Use Table 1 given at the end of the question paper. [2]

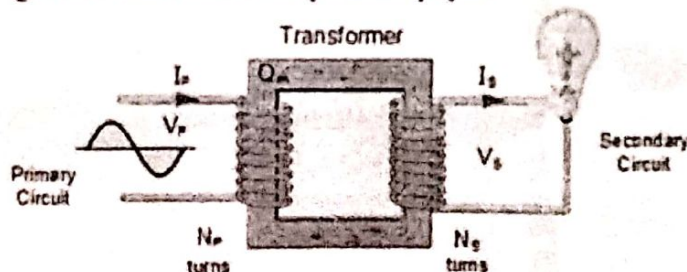


FIGURE 5A

B. Explain the concept of All-Day Efficiency of a transformer using a numerical example, OR Mathematically show that the efficiency of a voltage transformer is maximum when iron losses and copper losses are approximately equal to each other. [3]

6. A. A source which can be represented by a voltage source of 8-V RMS in series with an internal resistance of $1000\ \Omega$ is connected to a $100\ \Omega$ load resistance through an ideal lossless transformer. Calculate the value of the turns ratio required to ensure that maximum power is supplied to the load. Also calculate the maximum power supplied to the load. [2]
 B. A 2300-VA, 230/115-V, 50 Hz voltage transformer has primary winding resistance = $10\ \Omega$ and secondary winding resistance = $1\ \Omega$. The winding inductances are negligible and so are the core losses. Calculate a) full-load primary current, b) full-load secondary current, c) turns ratio of the transformer, d) Percentage voltage regulation, and e) full-load efficiency. [3]

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

AWG	Diameter [inches]	Diameter [mm]	Area [mm ²]	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	1.027024	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	2.588088	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	133.6568	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