EEL 100 – Introduction to Electrical Engineering
Major Examination
Electrical Engineering Department, Indian Institute of Technology Delhi
Maximum Marks: 35, Time: 2 Hours
Date: 2nd May 2014

Note:

1. **All questions are compulsory.**
2. **Make sure, you highlight the final answer (underline / box etc.), for numerical type problems.**

1. For the magnetic circuit shown in Figure 1(a) & 1(b), the relative permeability of the core is 5000. Thickness of the core is 1 cm.

a. For magnetic circuit of Figure 1(a), find out the MMF required to establish flux Φ_1 (flux linking the coil) equal to 0.75 mWb. $\mu_0 = 4\pi \times 10^{-7} H/m$ **(3 Marks)**

b. Now, with the same magnetic core and coil, two air gaps are cut exactly at the centre of the respective limbs, as shown in Figure 1(b). If the MMF is now made two times that of case (a), find out, what should be the lengths of air gaps, LG_1 and LG_2, so that the values of fluxes Φ_1, Φ_2 and Φ_3 remain the same as in case (a). Note that $LG_2 = 2LG_1$. Consider core reluctance in the middle and the right limb to be equal to that calculated in part (a). Neglect fringing effect. **(4 Marks)**

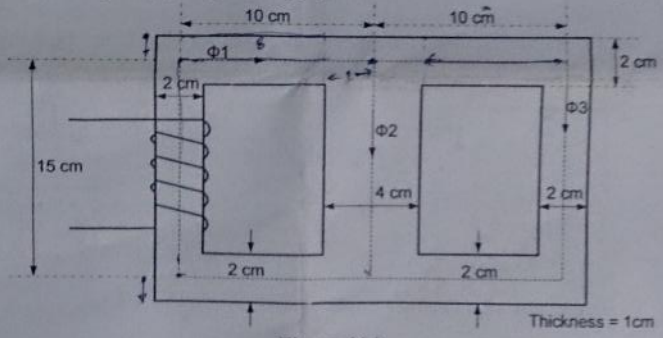


Figure 1(a)

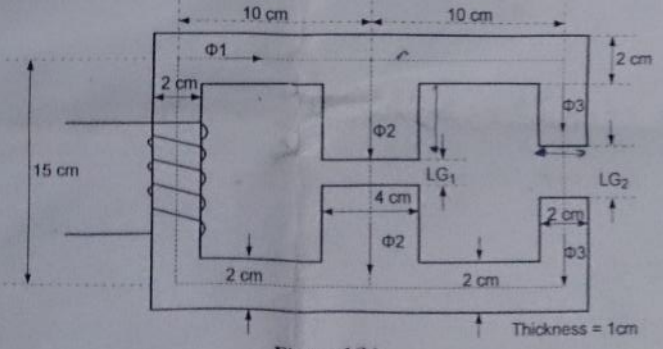


Figure 1(b)

2. Neutral of three phase supply is connected to the neutral of three phase star connected load. The phase currents in load are: $I_a = 24\angle 40^\circ, I_b = 24\angle 160^\circ, I_c = 24\angle -80^\circ$. Determine the magnitude and phase angle of the current flowing in the neutral. The supply is balanced, with $V_{an} = 240\angle 0^\circ$ taken as reference. **(2 Marks)**

3. Simplify the following Boolean expression using the basic properties of Boolean algebra:

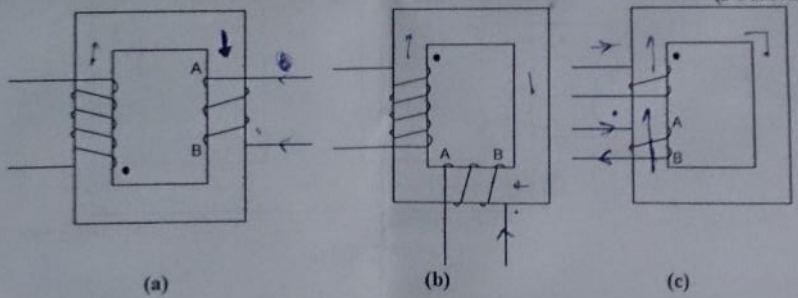
$$F(x,y,z,w) = \overline{x\bar{y} + z} + z + xy + wz$$

Mention the property used in each step of simplification. **(5 Marks)**

4. A 100KVA transformer has 400 turns on primary and 80 turns on secondary. Transformer has primary and secondary resistances of 0.3Ω and 0.01 Ω, respectively and the corresponding leakage reactance are 1.1 Ω and 0.035 Ω, respectively. The supply voltage is 2200V. Calculate the equivalent impedance referred to secondary. **(2 Marks)**

5. Armature voltage of a DC generator is 200volts. If the flux is reduced by 25% what should be the percentage change in the speed so that the armature voltage remains constant? **(2 Marks)**

6. In each of the following figures 2(a), 2(b) and 2(c), a magnetic core with two coils is shown. A 'dot' is marked near one of the coils. What is the appropriate position of 'dot' – 'A' or 'B' on the other coil? Do not explain. Only state the correct answer. **(3 Marks)**



(a) (b) (c)

Figure 2

7. For a series R-L-C network supplied by voltage $v(t) = 120\sin(3141.6t + 20^\circ)$, R = 100 Ω, L = 0.1H., what should be value of capacitance C so that the circuit resonates at the supply frequency? **(1 Mark)**

$x\bar{z} + xy + \bar{y}z + z$

8. In Figure 3, what will be the Thevenin impedance as seen from terminals A-B? **(4 Marks)**

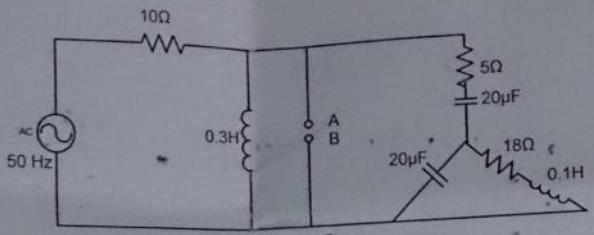


Figure 3

9. A 50 KVA, 2200/110 V transformer, when tested, gave the following results:
OC Test: HV Open, measurements on LV side: 400W, 10A, 110V
SC Test: LV shorted, measurements on HV side: 808 W, 22.73A, 90V **(4 Marks)**

a. Calculate:

i. Resistance of magnetizing branch (r_c)

ii. Reactance of magnetizing branch (x_ϕ)

iii. Equivalent resistance of winding as seen from HV side (R_{eH})

iv. Equivalent reactance of winding as seen from HV side (X_{eH})

b. Calculate efficiency of transformer at full load with 0.8 power factor lagging. **(1 Marks)**

10. State True or False

a. The hysteresis losses in a transformer are proportional to square of the frequency of the applied voltage. **(1 Mark)**

b. A compound wound DC generator has series connected as well as shunt connected field winding. **(1 Mark)**

c. The success of voltage build up in a shunt wound DC generator will depend on value of series field resistance. **(1 Mark)**

d. Three equal inductive type impedances, whether connected in star or delta, draw same amount of total reactive power from the supply. **(1 Mark)**

----------ALL THE BEST----------