Birla Institute of Technology & Science,

Semester-I, 2016-17

EEE / INSTR F 211 Electrical-Machines,

Tutorial Sheet No.-2

1. Two coils, connected in series, have self inductance L_1 = 2H and L_2 = 3H respectively. Relative motion is provided to these so that the mutual inductance varies as $M = 0.5 \cos 3t$. Find the voltage across the series combination if it is excited by (*a*) a DC current of magnitude *I*, and (*b*) an AC current given by $I_m \cos 3t$.

[(a) $-3I \sin 3t$, (b) $-15I_m \sin 3t - 3I_m \sin 6t$]

2. Consider two magnetically linked coils on a common magnetic core and identical number of turns. Initially, both coils carry the same current. (*a*) By what factor does the stored magnetic energy change if the current in one coil is doubled, keeping the other unchanged? (*b*) If the two currents are maintained identical all the time (say, by connecting the coils in series), by how much should they be increased to double the total stored magnetic energy?

3. The air gap under a motor pole is 1.5mm in length, and the effective pole face area is 516cm^2. The pole has a winding of five turns mounted on it, with a total resistance of 0.05Ω. Assuming the reluctance of the iron part of the magnetic circuit to be 1/5 times that of the air gap, calculate the voltage drop across the coil when 150A, 25Hz current is passed through it.

[21V]

4. A 2kV, 50Hz transformer primary has 300 turns. The core has a 100cm mean path length, 1000cm^2 cross section, relative permeability of 1800, and results in iron loss amounting to 400W when the coil is excited from a 2kV source. Calculate the primary no load current.

[0.36A]

5. The magnetization curve of a core with 2000 turns coil is given by

$$\varphi = 3.55 \times 10^3 \cdot i^{0.21}$$

where the current is in amperes and the flux in webers. Find the inductance and energy stored for the combination as a function of current.

[$7.1\, i^{-0.79}$ H; $1.232 i^{1.21}$ J]

6. Calculate the primary no-load current and the no load power factor of a single phase transformer having 500 primary turns, 50 secondary turns, and a core with iron of density 7.8g/cm^3. The maximum flux density for the core is 1wb/m^2, at which it requires an mmf of 5A-t/cm and has iron loss amounting to 2W/kg of iron. The transformer has 3kV, 50Hz primary rated voltage, and a mean length of magnetic path 150cm with joints equivalent to 0.1mm air gap.

[1.192A, 0.177]

7. A 16.67kVA, 7200/120V, 60Hz, two winding transformer has the following equivalent circuit parameters:
Rc = 311kΩ, Xm = 58kΩ, R_1 = 18.7Ω, X_1 = 77.8Ω, R_2 = 0.00519Ω, X_2 = 0.0216Ω.
The voltage applied to the high voltage (HV) side is adjusted so as to supply a 120V, 16.67kVA, upf load connected to the low voltage (LV) side. Find the primary current, required primary terminal voltage, core and copper losses, and the efficiency under these conditions.

[$2.342/\underline{-3.21}^{o}$A, $7303/\underline{2.82}^{o}$V, 169W, 202.7W, 97.8%]

8. A single phase transformer is to be designed to have a primary voltage of 33 kV and a secondary voltage of 6.6 kV. If the maximum flux density permissible is 1.2 Wb/m2 and the number of primary turns is 1250, calculate the number of secondary turns and the cross section area of the core for an operating frequency of 50 Hz.

[250, 0.0993 m2]

9. Show that the voltage regulation of a transformer is approximately given by $[V_{sc} \cos(\varphi - \varphi_{sc})] / V_{rated}$, where V_{sc} is the voltage required to circulate rated current on short circuit, $\cos \varphi_{sc}$ is the power factor on short circuit, and $\cos \varphi$ is the operating power factor.

10. A 200/400 V single phase transformer gave the following test results:
    a. With LV winding short circuited, HV side measurements were 20 V, 10 A, 100 W.
    b. With HV winding open circuited, LV side measurements were 200 V, 1 A, 60 W

    If a load impedance of 80 + j35 Ω is connected to the HV terminals, determine per-cent regulation and efficiency when 200 V is applied to the LV terminals.

    [2%, 95.5%]

11. A 200/100 V, 50 Hz, single phase transformer has an actual primary leakage impedance of 0.15 + j0.76 Ω and an actual secondary leakage impedance of 0.04 + j0.19 Ω. The transformer supplies a load of impedance 3.92 + j2.62 Ω. Calculate the regulation and efficiency if the primary is supplied at rated voltage.

    [5.6%, 97.9%]