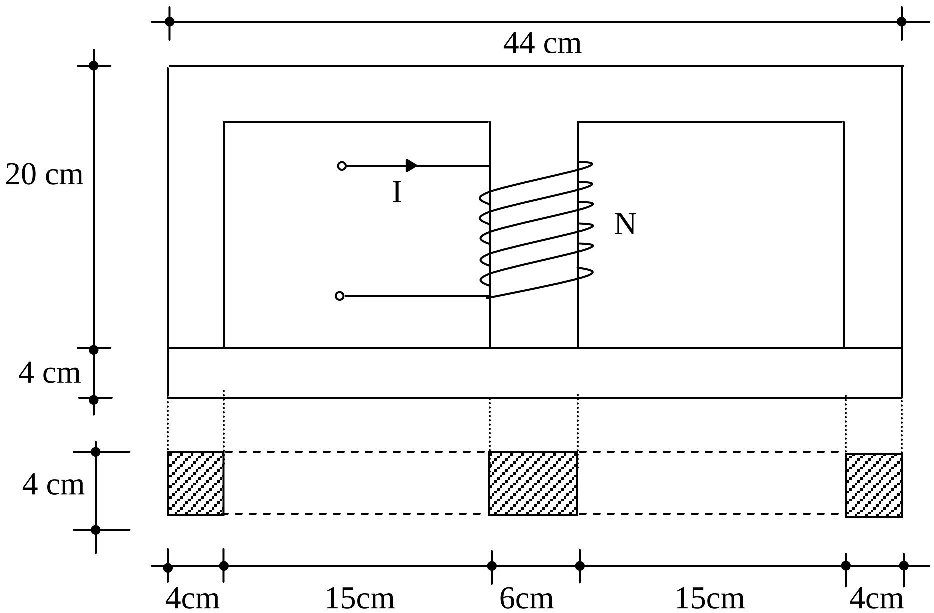
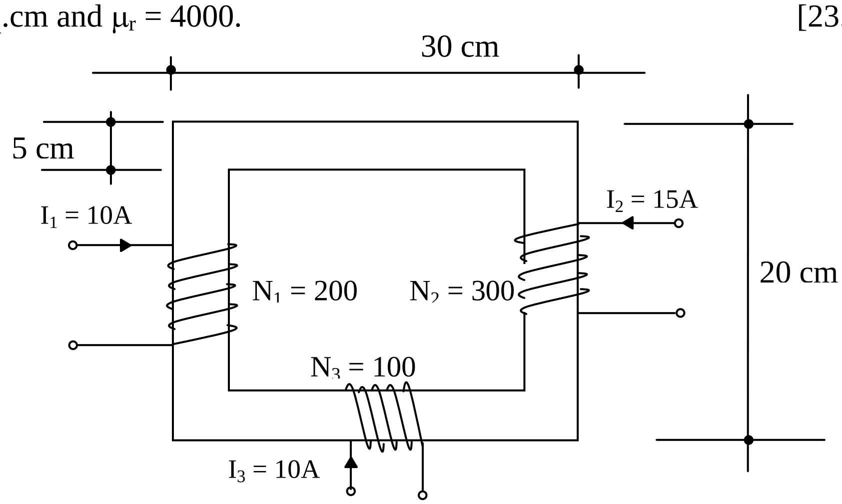
Department of Electrical Engineering
Pulchowk Campus
Tutorial #1
(Electric Machine –I)

1. A 30 cm long circular iron rod is bent into circular ring and 600 turns of windings are wound on it. The diameter of the rod is 20 mm and relative permeability of the iron is 4000. A time varying current i = 5 sin 314.16t is passed through the winding. Calculate the inductance of the coil and average value of emf induced in the coil. [1.89H, 189V]

2. For the Magnetic circuit shown below, calculate the Amp-turn (NI) required to establish a flux of 0.75 wb in the central limb. Given that μ_r = 4000 for iron core.
[40.4×10^3 Amp-turn]



3. Calculate the net magnetic flux in the core of the following magnetic circuit and show the direction of magnetic flux in the core. Given that cross sectional area of the core is 25 sq.cm and μ_r = 4000. [23.56 mwb, clockwise]

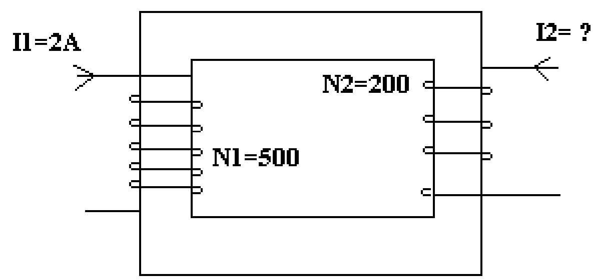


4. What are the different types of magnetic losses? How can they be minimized?

5. Explain Faraday's law of electromagnetic induction. Explain statically and dynamically induced emf?

6. A magnetic circuit consists of a circular iron core having mean diameter of 10 cm and cross sectional area of 100 sq. mm and an air gap of 2 mm. The core has 600 turns of winding. Calculate the magnitude of electric current to be passed through the winding to produce an air gap flux of 1 Tesla. Given that the relative permeability of the core is 4000.

7. In the figure given below, calculate the value of I_2 current required to establish a magnetic flux density of 1.2 wb/m^2 in the core. Given permeability of the core 600, the mean length of core 40 cm, area of core is 16 sq. m.



8. Calculate the net magnetic flux in the core of the circular magnetic circuit. Given that cross sectional area of the core is 25 sq.cm and relative permeability = 400, Mean diameter of the circular iron core = 55cm. No. of turns in the primary winding (N_1) =50 turns, Current flowing in the primary winding (I_1) =5A. [0.1818 wb]

9. A circular iron core has a cross sectional area of 5 sq.cm and mean length of 15 cm. It has two coils A and B with 100 turns and 500 turns respectively. The current in the coil A is changed from zero to 10 amps in 0.1 second. Calculate the emf induced in the coil B. Given that, the relative permeability of the core is 3000. [62.5 V]

10. An iron ring of mean diameter 100 cm and cross sectional area 10 cm^2 is wound with 1000 turns and has μ_r =2000. Compute (i) reluctance (ii) flux produced when the current through the coil is 1A (iii) Flux in the ring if a saw cut of 1 mm length is made ,the current through the coil remaining the same.

Department of Electrical Engineering
Pulchowk Campus
Tutorial #2
(Electric Machine –I)

1. A 50 kVA, 50 Hz single phase transformer has 500 turns on primary winding and 100 turns on secondary winding. The primary winding is supplied by 3000V, 50 Hz ac voltage with full resistive load connected on secondary side. Calculate:
   i) Emf induced in secondary winding
   ii) Primary and secondary windings currents
   iii) Maximum flux in the core.

   Assume that it is an ideal transformer. [Ans: 600V, 16.66A, 83.33A, 27.02mwb]

2. A step up transformer supplies a current of 5 amp to the load at 200 V. The power factor of the load is 0.8 lagging. Given that R_1 = 0.5 ohm, X_1 = 1 ohm, R_2 = 2 ohm, X_2 = 4 ohm, k = 2, R_0 = 450 ohms and X_0 = 250 ohms. Calculate the magnitude and phase of V_1 and I_1 with V_2 as reference phasor and calculate the input power factor.
   [Ans: $V_1 = 129.98\angle 6.5^0$ V, $I_1 = 10.56\angle -37.88^0$ A and input pf = 0.71 lagging]

3. A 230V/ 2300V single-phase transformer is excited by 230V ac voltage. The equivalent resistance and reactance referred to primary side are 0.1 ohm and 0.4 ohm respectively. Given that R_0 = 500 ohms and X_0 = 200 ohms. The load impedance is (400 + j600) ohm. Calculate: a) Primary current b) Secondary terminal voltage c) Input power factor.
   [Ans: I_1 = 30 A V_2 = 2075.4V, and input pf = 0.52 lagging]

4. A 25 kVA, 6600V/ 250V single phase transformer has the following parameters: R_1 = 8 ohm, X_1 = 15 ohm, R_2 = 0.02 ohm, X_2 = 0.05 ohm. Calculate the full load voltage regulation at a power factor a) 0.8 lag b) unity c) 0.8 lead.
   [Ans: 2.7 %, 1.3 % and -0.782 %]

5. A 20 kVA, 250V/2500V, 50 Hz single phase transformer gave the following test results:

   No-load test (on L.V. side): 250V, 1.4 A, 105 watts
   Short circuit test (on H.V. side): 120V, 8 A, 320 watts

   Calculate the equivalent circuit parameters referred to primary side and draw the equivalent circuit.
   [Ans: Ro = 595.2 ohm, Xo = 187.26 ohm, R_{01} = 0.05 ohm and X_{01} = 0.14 ohm]

6. A 300 kVA, 11 kV/400, Δ/Y, 3-phase transformer has a star connected balanced load of 60 kW at a power factor of 0.8 lagging in each phase. Calculate the primary line current.
   [Ans: 11.81 amp]

Department of Electrical Engineering
Pulchowk Campus
Tutorial #3
(Electric Machine)

1. A dc shunt motor draws a current of 112 A from 480 V dc source. The armature winding and field winding resistances are $0.2\,\Omega$ and $240\,\Omega$ respectively. The motor has 6 poles and the armature winding has 864 conductors. The flux per pole is 0.05 weber. Calculate:
a) Armature current.
b) Speed
c) Torque developed by the armature. [110A, 636 RPM, 756N-m]

2. A 240V dc series motor has a total resistance of $0.2\,\Omega$. When the speed is 1800 rpm, the motor draws a current of 40 A. Calculate the value of resistance to be connected in series with the armature so as to limit the speed to 3600 rpm when the line current is 10A. [$12.2\,\Omega$]

3. A 250V dc shunt motor has armature winding resistance of $1\,\Omega$ and field winding resistance of $125\,\Omega$. It draws a current of 25 A at a speed of 900 rpm. It is required to increase the speed to 1100 rpm keeping the load torque constant. Calculate the value of additional resistance to be connected in series with field winding to achieve this speed. [$31.83\,\Omega$]

4. A 250V dc shunt motor has armature winding resistance of $0.5\,\Omega$ and field winding resistance of $125\,\Omega$. It draws a current of 32A and runs at speed of 1100 rpm.Calculate the value of resistance to be connected in series with the armature in order to reduce the speed to 750 rpm keeping the load torque constant. [$2.49\,\Omega$]

5. A 240V dc shunt motor has armature winding resistance of $0.4\,\Omega$ and field winding resistance of $120\,\Omega$. It draws a current of 27A at half load and the corresponding speed is 600 rpm.
   a) If a resistance of $1\,\Omega$ connected in series with the armature winding keeping the load torque constant to half load torque, calculate the new speed.
   b) If a resistance of $1\,\Omega$ connected in series with the armature winding and the load torque is increased to full load torque, calculate the new speed.
   [534.78 RPM, 443.48 RPM]

6. The data obtained from no-load magnetization test of a dc shunt generator running at 800 rpm is as follow:

Field current(I_f in Amp) :	0	1.6	3.2	4.8	6.4	8	9.6	11.2
Emf (E in volts) :	10	148	285	390	460	520	560	590

The field winding resistance is 60 ohms.

   a) Draw the OCC and calculate the emf generated by the machine at no-load.

b) Find the critical resistance of the machine at 800 rpm. [550V, 91 ohms]

7. A 4-pole dc shunt generator has wave wound armature. The armature and field winding resistances are 0.2 ohm and 60 ohms respectively. The brush contact drop is 1V per brush. The generator is delivering a power of 3kW at 120V. Calculate :

   a) Total armature current coming out from the brush.
   b) Current in each armature conductor
   c) Generated EMF (E) [27A, 13.5A, 127.4V]

8. A dc series generator is running at 800 rpm and delivering a power of 6 kW to the load at 120V. The armature and field winding resistance are 0.1 ohm and 0.3 ohm respectively. When the load is increased to 9 kW, the speed is increased to 1200 rpm. Calculate the new values of armature current and load terminal voltage. [46.85A, 145.27 V]

9. A dc compound generator has to supply a current of 120A at 120V. The shunt field, series field and armature winding resistances are 30 ohm, 0.05 ohm and 0.1 ohm respectively. Calculate the emf generated by the armature in the following two cases :

   i) Long shunt connection
   ii) Short shunt connection [138.6V, 138.42V]

10. Calculate the resistance of the load which consumes a power of 5 kW from a dc shunt generator whose load characteristic is described by the equation : $V_L = 250 - 0.5*I_L$.
    [11.48 ohms]

***** End ******