Section-C
Lecture-1

- Introduction :
- Design detailed: DC Machines
- Calculation of Armature main Dimensions and flux for pole.
- Design of Armature Winding & Core.
- Design of Shunt Field & Series Field Windings.
- Design detailed: Transformers
- Core Type Power Transformer
- Design of Magnetic Frame

Design of LV Winding and HV Winding:

- Tank Design & Weights
- Shell Type Power Transformer
- Synchronous Machines:
- Salient Pole Type
- Calculation ofthe Stator Main Dimensions & Flux/Pole

Design of Armature Winding & Core

- Non-Salient Pole (Cylindrical Solid Rotor) Type
- Three-Phase Induction Motors:
- Squirrel Cage Motor
- Slip-Ring Type Induction Motor
- a) Higher Efficiency
- (b) Lower weight for given KVA output (Kg/KVA)
- (c) Lower Temperature-Rise
- (d) Lower Cost
- (e) Any other parameter like higher PF for induction motor, higher reactance etc

- Computer-Aided Design:
- Explanation of Details of Flowchart:
- Input Data to be Fed into the Program:
- Data:

Dc machine lecture-2

- Based on winding type of annature, DC machines are categorized as lap wound and wave
- wound. Theory portion of design is not given in this book, but necessary fonnulae, curves
- and tables given in standard books are made use of. Since the machine is the same for both
- operations of Generator and Motor, same design is applicable for both.

Sequential Steps for Design of Each Part and Programming Simultaneously:

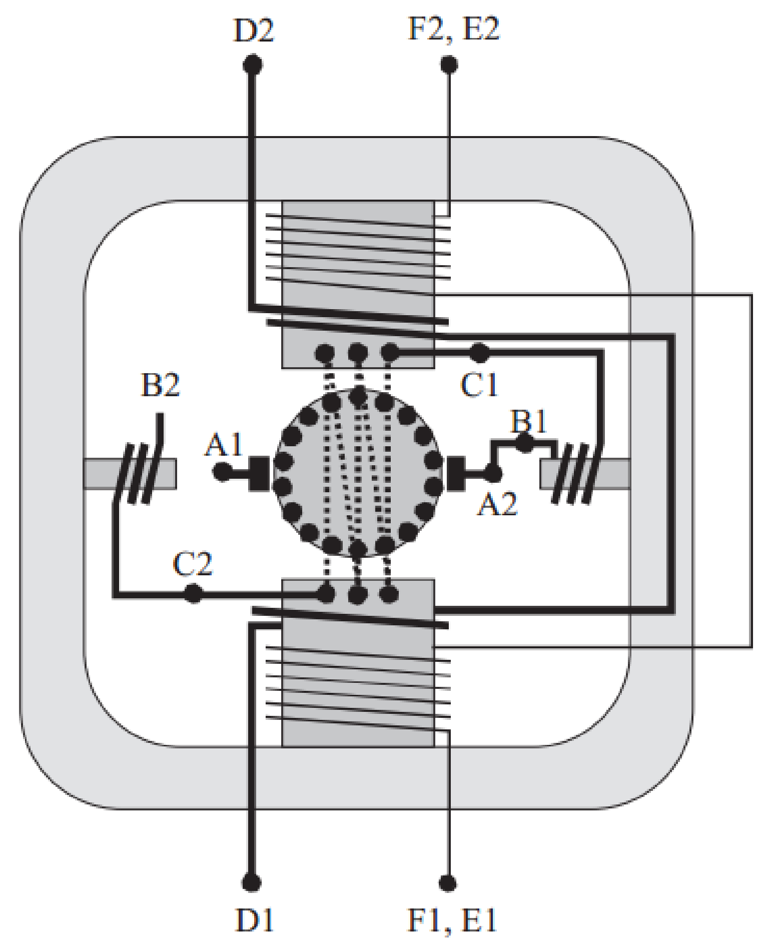
- (a)Calculate Output Coefficient, Main dimensions of armature (viz) D,L and Flux/Pole checking the Peripharal velocity and Volts between commutator segments
- (b) Calculate no. of slots, size of slot, conductor size, checking current density, current volume, slot balance. Calculate tooth flux density, Height of core, Wt. of iron, Iron losses and Temp rise
- (c) Calculate dimensions of poles, Field Coils, Yoke and Amp-Turns required

- (d) Calculate Copper size, No. of turns for Shunt and series fields
- (e) Detennine the diameter of Commutator and no. and size of brushes. Check for Periphoral velocity and gap between brush arms
- (f) Calculate the dimensions of Interpoles and Interpole winding. Calculate total losses, efficiency, total weight and Kg/KW.

Configuration of DC Machines:

- Operation of a DC machine is based chiefly on the cooperation of two windings, namely a rotating armature winding and a stationary field winding.
- The armature winding is embedded in slots on the outer periphery of the electrical sheet core and, although the flux variations in the iron core of the field winding are not significant, the pole shoes are also made of electrical sheet.
- The pole shoes are fastened to the yoke that closes the magnetic circuit.

Motor



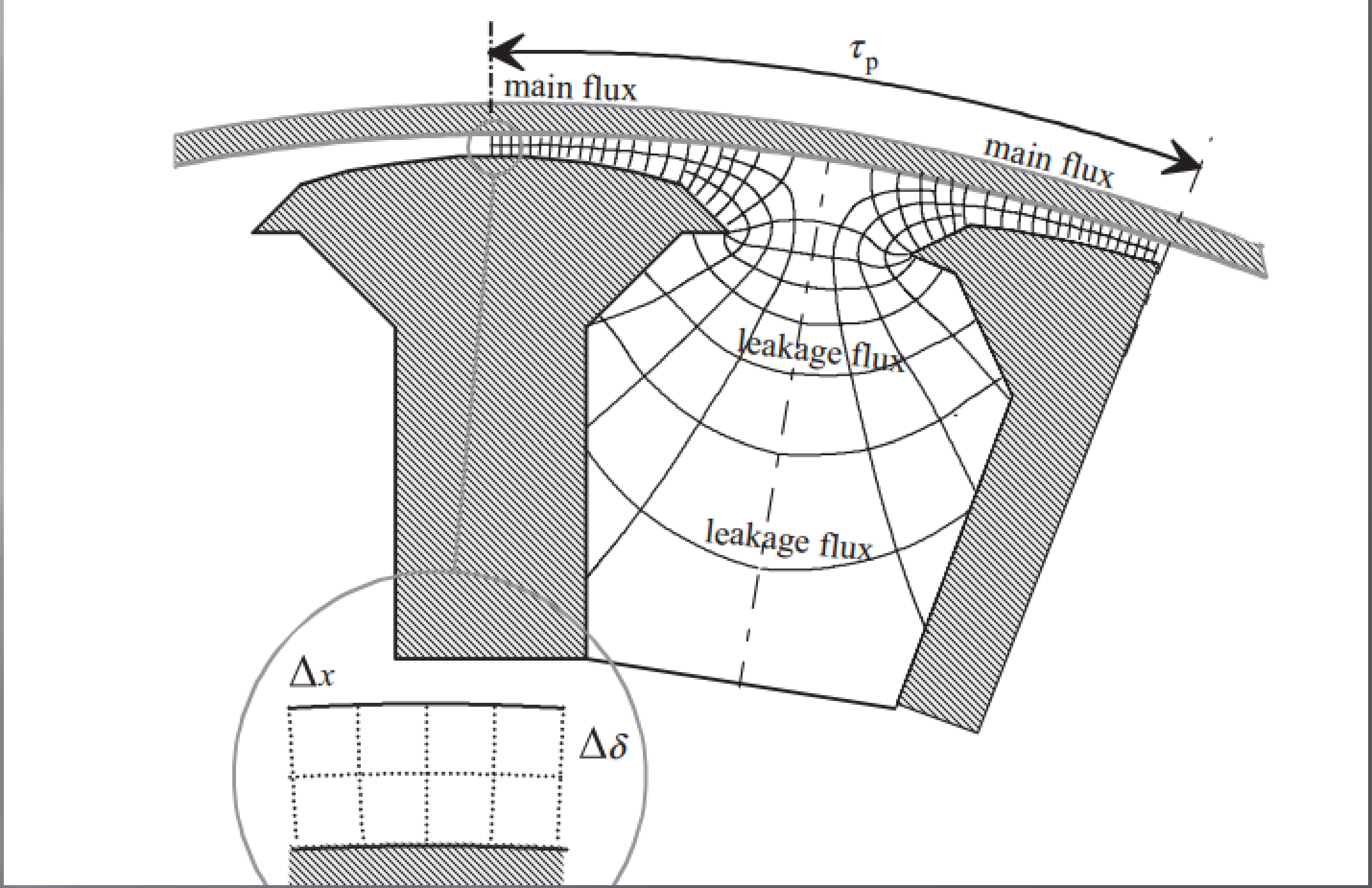
Operation and Voltage of a DC Machine:

- A DC generator converts mechanical energy into electrical energy. A power engine rotates
- the armature in the magnetic field generated by a field winding, and as a result an alternating voltage is induced in the armature winding. The voltage is now rectified by the ommutator.
- An alternating voltage is induced in each coil turn of the armature winding. The commutator acts as a mechanical rectifier connecting the AC armature to the external DC circuit.

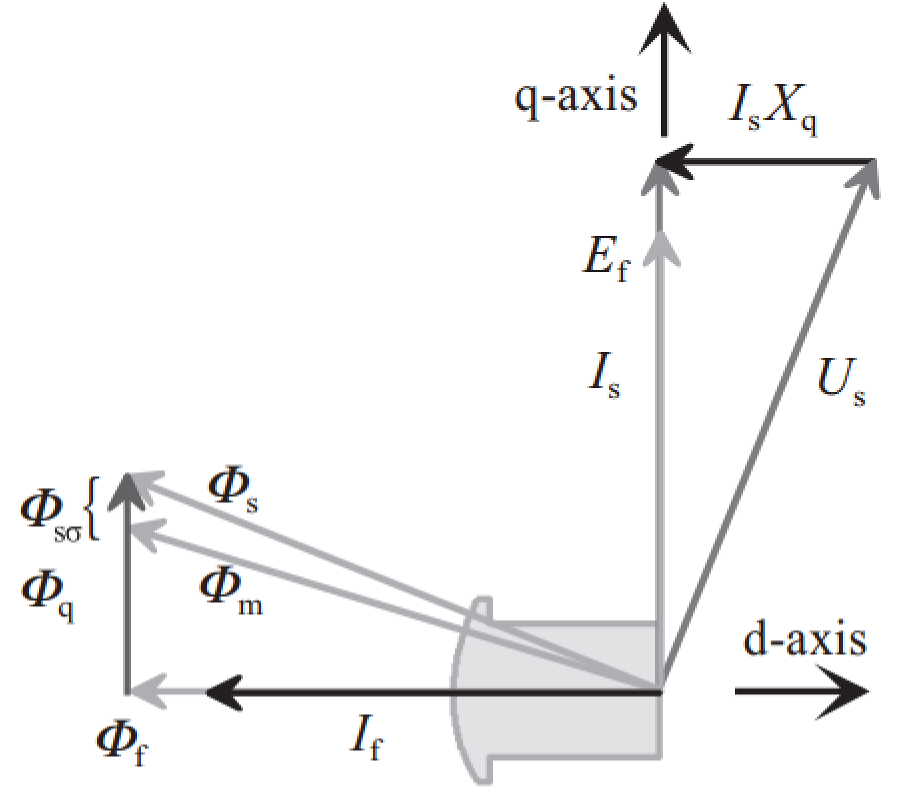
Lecture-3

- Air Gap and its Magnetic Voltage
- The air gap of an electrical machine has a significant influence on the mmf of the magnetic
- circuit. Nonsalient-pole machines and salient-pole machines have different types of air gaps
- that greatly influence machine performance

View of stator and rotor



Flux vector diagram:



Induction machine

- The induction machine is basically an a.c. polyphase machine connected to an a.c. power grid, either in the stator or in the rotor. The a.c. power source is, in general, three phase but it may also be single phase. In both cases the winding arrangement on the part of the machine–the primary–connected to the grid (the stator in general) should produce a traveling field in the machine airgap.

Contii.

- This traveling field will induce voltages in conductors on the part of the machine not connected to the grid (the rotor, or the mover in general), - the secondary.
- If the windings on the secondary (rotor) are closed, a.c. currents occur in the rotor.

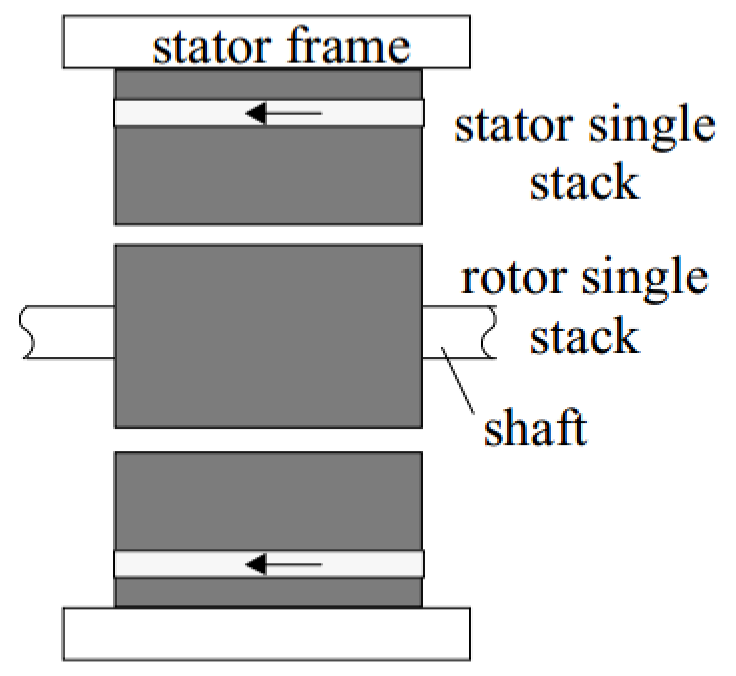
Lecture-4

- construction aspects and operation principles of induction machine:
- The main parts of any IM are
- • The stator slotted magnetic core
- • The stator electric winding
- • The rotor slotted magnetic core
- • The rotor electric winding

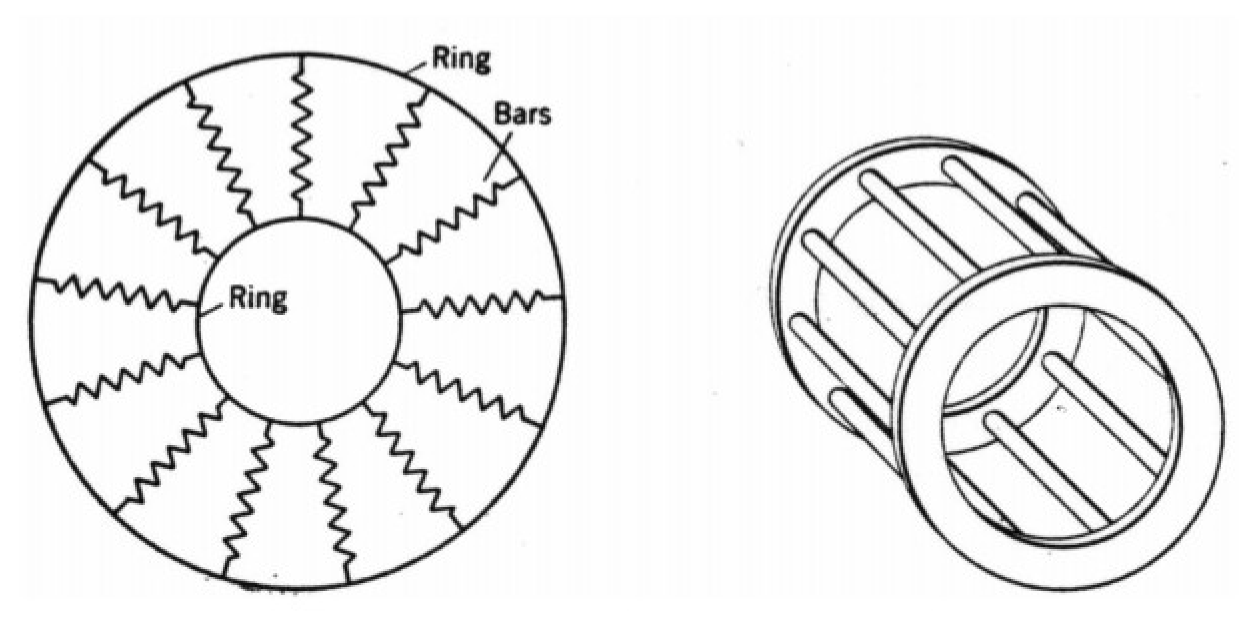
- • The rotor shaft
- • The stator frame with bearings
- • The cooling system
- • The terminal box

- The induction machines may be classified many ways. Here are some of them:
- • With rotary or linear motion
- • Three phase supply or single-phase supply
- • With wound or cage rotor

Magnetic core



Cage rotor



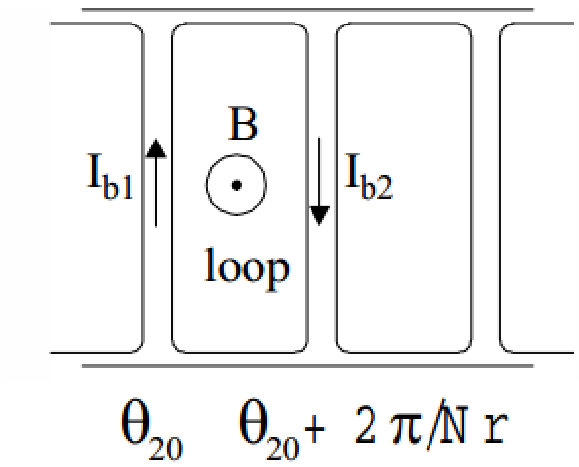
OPERATION PRINCIPLES OF Ims:

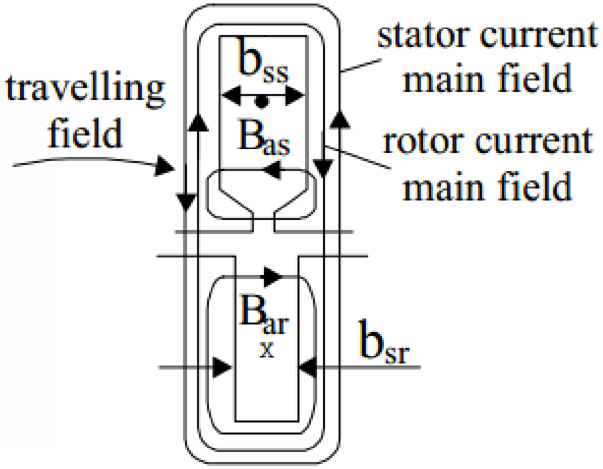
- The operation principles are basically related to torque (for rotary IMs) and, respectively, thrust (for LIMs) production. In other words, it is about forces in traveling electromagnetic fields. Or even simpler, why the IM spins and the LIM moves linearly.
- Basically the torque (force) production in IMs and LIMs may be approached via
- • Forces on conductors in a travelling field
- • The Maxwell stress tensor [3]
- • The energy (coenergy) derivative
- • Variational principles (Lagrange equations) [4]

Current direction :

$$n_{sr} = \frac{f_1}{p_1} - n = S \cdot \frac{f_1}{p_1}$$

$$B(\theta_r, t) = B_m \cos(p_1\theta_2 - S\omega_1 t)$$





- Transformer Losses
- 2.2.9.1 No-Load Loss and Exciting Current
- When alternating voltage is applied to a transformer winding, an alternating magnetic flux is induced
- in the core. The alternating flux produces hysteresis and eddy currents within the electrical steel, causing
- heat to be generated in the core. Heating of the core due to applied voltage is called no-load loss. Other
- names are iron loss or core loss. The term “no-load” is descriptive because the core is heated regardless
- of the amount of load on the transformer. If the applied voltage is varied, the no-load loss is very roughly
- proportional to the square of the peak voltage, as long as the core is not taken into saturation. The current
- that flows when a winding is energized is called the “exciting current” or “magnetizing current,” consisting
- of a real component and a reactive component. The real component delivers power for no-load losses
- in the core. The reactive current delivers no power but represents energy momentarily stored in the
- winding inductance. Typically, the exciting current of a distribution transformer is less than 0.5% of the
- rated current of the winding that is being energized.

Lecture-5

Load Loss

- A transformer supplying load has current flowing in both the primary and secondary windings that will
- produce heat in those windings. Load loss is divided into two parts,
- R loss and stray losses.

- R Loss

- Each transformer winding has an electrical resistance that produces heat when load current flows.

- Resistance of a winding is measured by passing dc current through the winding to eliminate inductive effects.

- Stray Losses
- When alternating current is used to measure the losses in a winding, the result is always greater than the R measured with dc current. The difference between dc and ac losses in a winding is called “stray loss.”
- One portion of stray loss is called “eddy loss” and is created by eddy currents circulating in the winding conductors.
- The other portion is generated outside of the windings, in frame members, tank walls,bushing flanges, etc. Although these are due to eddy currents also, they are often referred to as “other strays.

- The generation of stray losses is sometimes called “skin effect” because induced eddy currents tend to flow close to the surfaces of the conductors.
- Stray losses are proportionally greater in larger

transformers because their higher currents require larger conductors. Stray losses tend to be proportional to current frequency, so they can increase dramatically when loads with high-harmonic currents are served

. The effects can be reduced by subdividing large conductors and by using stainless steel or other nonferrous materials for frame parts and bushing plates.