BEEE Unit–4 Detailed Notes Electrical Machines

DC Machine

Definition:
A DC machine is an electrical machine that converts mechanical energy into electrical energy or electrical energy into mechanical energy.

Construction:
1. Yoke – Provides support and protection.
2. Pole Core & Pole Shoe – Produce magnetic field.
3. Armature Core – Carries armature winding.
4. Armature Winding – EMF is induced here.
5. Commutator – Converts AC into DC.
6. Brushes – Collect current from commutator.

Working Principle:
DC machine works on Faraday's law of electromagnetic induction. When conductors rotate in magnetic field, EMF is induced.

Applications:
Electric traction, cranes, elevators and rolling mills.

Induction Machine

Definition:
An induction machine is an AC machine in which rotor current is induced by electromagnetic induction.

Construction:
1. Stator – Stationary part carrying 3-phase winding.
2. Rotor – Rotating part.

Types of Rotor:
• Squirrel Cage Rotor
• Slip Ring Rotor

Working Principle:
When 3-phase supply is given to stator, rotating magnetic field is produced. Rotor conductors cut flux and current is induced. This produces torque and rotor starts rotating.

Applications:
Fans, pumps, compressors, conveyor belts and industries.

Synchronous Machine

Definition:
A synchronous machine is an AC machine operating at synchronous speed.

Types:
1. Synchronous Generator
2. Synchronous Motor

Working Principle:
Rotor rotates at same speed as rotating magnetic field.

Advantages:
• Constant speed
• High efficiency
• Power factor improvement

Applications:
Power generation stations and industrial drives.

Slip in 3-Phase Induction Motor

Definition:
Slip is the difference between synchronous speed and rotor speed.

Formula:
$s = (Ns – Nr) / Ns$

Where:
Ns = Synchronous speed
Nr = Rotor speed

Importance of Slip:
• Torque production
• Speed control
• Rotor current generation

Torque-Slip Characteristics

Torque-Slip Characteristics:

1. At low slip region, torque increases linearly with slip.

2. At medium slip, maximum torque occurs.

3. At high slip region, torque decreases with increase in slip.

Importance:
Used for understanding motor performance and starting behavior.

Losses in Electrical Machines

Types of Losses:

1. Copper Losses:
Due to resistance of windings.
Formula: $Pc = I^2R$

2. Iron Losses:
• Hysteresis Loss
• Eddy Current Loss

3. Mechanical Losses:
• Friction Loss
• Windage Loss

4. Stray Losses:

Due to leakage flux.

Importance of Reducing Losses:
• Higher efficiency
• Less heating
• Better performance

Comparison of Machines

DC MachineInduction MachineSynchronous Machine Operates on DCOperates on ACOperates on AC Uses commutatorNo commutatorNo commutator Speed variesSpeed slightly variesConstant speed High maintenanceLow maintenanceModerate maintenance

Most Important 14 Mark Questions

1. Explain construction and working of DC machine.
2. Explain construction and working of induction motor.
3. Explain synchronous machine.
4. Explain slip in induction motor.
5. Explain torque-slip characteristics.
6. Explain losses in electrical machines.
7. Compare electrical machines.

Quick Revision Formulas

DC Machine EMF:
$E = (P\Phi ZN)/60A$

Synchronous Speed:
$N_s = 120f/P$

Slip:
$s = (N_s - N_r)/N_s$

Copper Loss:
$P_c = I^2R$