Module – 3
DC MOTOR CONTROL

Lecture – 2

SPEED CONTROL OF DC MOTOR

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Outcomes
- List and describe different methods of DC motor speed control
- Explain operation of chopper drives
- Explain dynamic breaking of DC motor
- Explain methods of reversing DC motor
Introduction

- Speed of a dc motor can be controlled fairly easily
- basic speed equation of a dc motor

\[ n = \frac{V_t - I_a R_a}{K \Phi} \approx \frac{V_t}{K I_f} \]

- there are four variables that effect speed of a dc motor i.e. \( V_t, I_a, Ra, \) and \( I_f \)
- But \( I_a \) is determined by load,
- so to control speed, \( V_t, Ra, \) and \( I_f \) are commonly used.

Speed Control

- Field current in a shunt or compound motor can be readily varied by varying external field resistance.
  - Speed is inversely proportional to field current.
  - Increasing field resistance causes a decrease in field current and therefore an increase in speed.
- Inserting a variable resistance in series with the motor armature circuit armature resistance can be changed.
  - As the series resistance is increased, the motor speed decreases
  - Used only for series motor
- Motor speed can be controlled by varying the terminal voltage
  - Very efficient and is now widely used for below the nominal speed control
The speed corresponding to full armature voltage and full flux is known as base speed or nominal speed.

- In general, below base speed, the flux is at maximum and speed is controlled by armature voltage.
- Above base speed, the armature voltage is at or near maximum, and flux is reduced in order to raise the speed.

### DC Motor Drives – AC Drives

- The motor armature is supplied from three-phase ac source.
- A controlled rectifier is used to control the dc voltage to the armature.
- Field is generally supplied from a single phase controlled rectifier.
- Firing of both the rectifiers is controlled by control & logic circuitry.
DC / CHOPPER DRIVES

- widely used in traction application
- usually employed, when
  - source supply is dc
  - operation below base speed is important
- average voltage is varied by periodically switching the battery voltage on and off for varying intervals

![DC Chopper Drives Diagram]

DYNAMIC BRAKING

- stopping is achieved by reconnecting the motor as a generator.
- when the armature terminals are disconnected from source, a resistor is immediately connected across the armature.
- braking force is created by the current flow caused by the counter EMF and the resistor circuit.
- The mechanical energy stored in the moving parts is converted to electrical energy and dissipated across the resistor in the form of heat.
- motor cannot be stopped completely by dynamic braking alone
  - When motor slows down the generator action decreases and braking lessens.
Coil DB has one normally closed and one normally open contact.

When START button is pressed coil DB is energized and its NO contact closes, energizing coil M, which starts the motor.

When the STOP button is pressed DB and M are de-energized.

Normally closed contact of DB completes the braking circuit through the braking resistor R.

REVERSING OF DC MOTOR

- reversing the direction of current through either the armature or the field windings, not both.
- the armature current is usually reversed.
- done by using two pairs of contacts: one set for forward, and one set for reverse.
- Care must be taken when going from forward to reverse to prevent excessive current.
  - At the time of reversal, the counter EMF and the applied EMF will be of the same polarity and a high current will flow unless resistance is added.
Drum controller

- drum controller is a device used to manually reverse the direction of rotation of a dc motor
- The motor can be started in the forward direction by moving the handle to the FOR position.
- To reverse the direction, the handle is moved to the REV position.