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

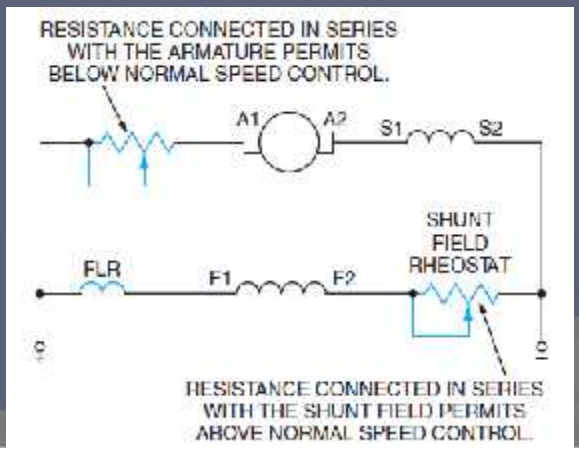
$$n = \frac{V_t - I_a R_a}{K\Phi} \approx \frac{V_t - I_a R_a}{KI_f}$$

- there are four variables that effect speed of a dc motor i.e. *Vt, Ia, Ra*, and *If*
- But *Ia* is determined by load,
- so to control speed, *Vt, Ra*, and *If* are commonly used.

## Speed Control

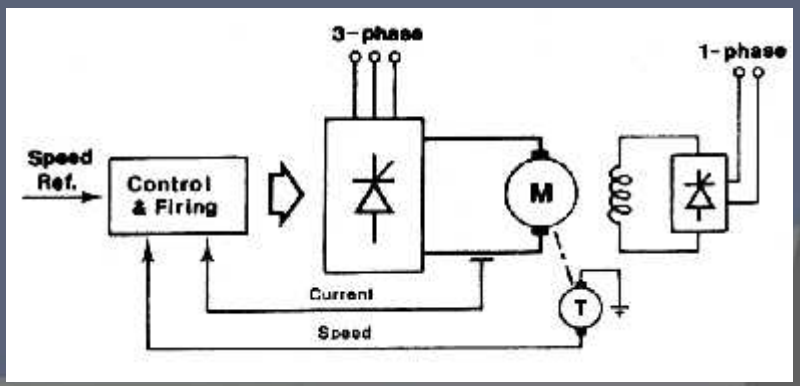
- Field current in a shunt or compound motor can be readily varied by varying external field resistance.
  - Speed is inversely proportional to field current.
  - Increasing field resistance causes a decrease in field current and therefore an increase in speed.
- Inserting a variable resistance in series 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



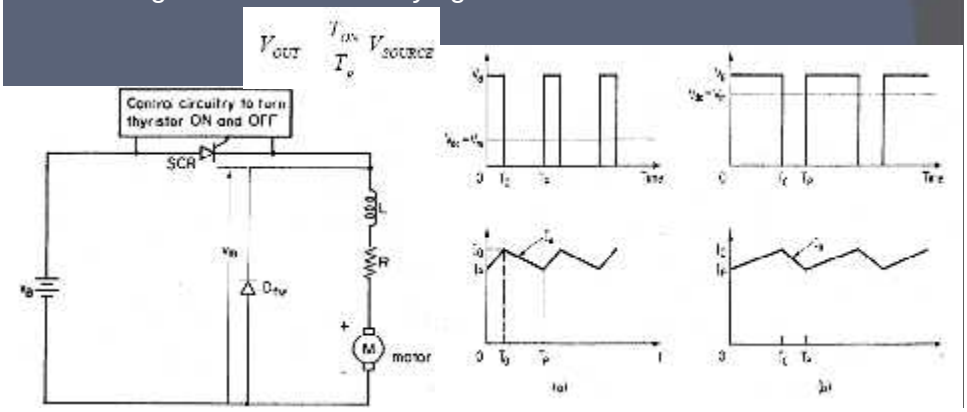

## DC Motor Drives – AC Drives

- 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

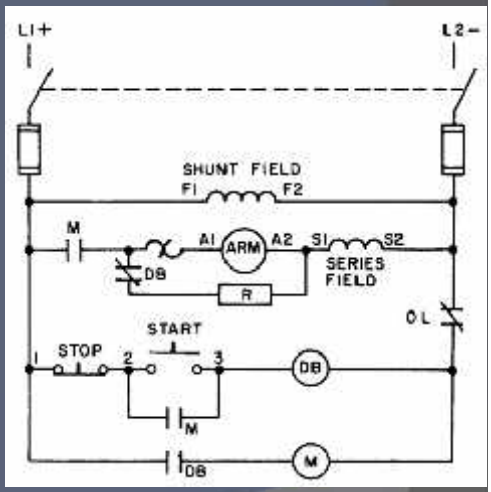
- widely used in traction application
- usually employed, when
  - source supply is dc
  - operation below base speed is important
- average voltage is varied by periodically switching the battery voltage on and off for varying intervals




## DYNAMIC BRAKING

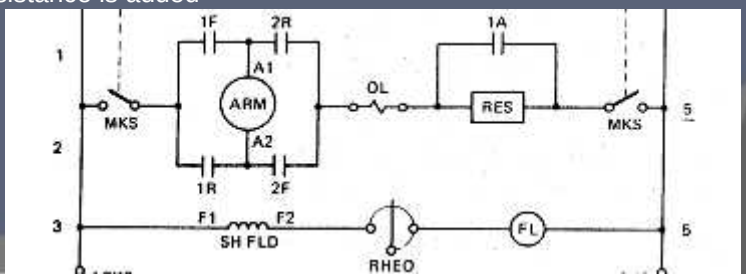
- stopping is achieved by reconnecting the motor as a generator.
- when the armature terminals are disconnected from source, a resistor is immediately connected across the armature.
- braking force is created by the current flow caused by the counter EMF and the resistor circuit.
- The mechanical energy 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