SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME: 23EEB210 / Electrical Machines and Drives

II YEAR / IV SEMESTER

Unit IV – SOLID STATE SPEED CONTROL OF DC DRIVES

Topic : Single Phase Half and Fully Controlled Rectifier Control of DC Drive

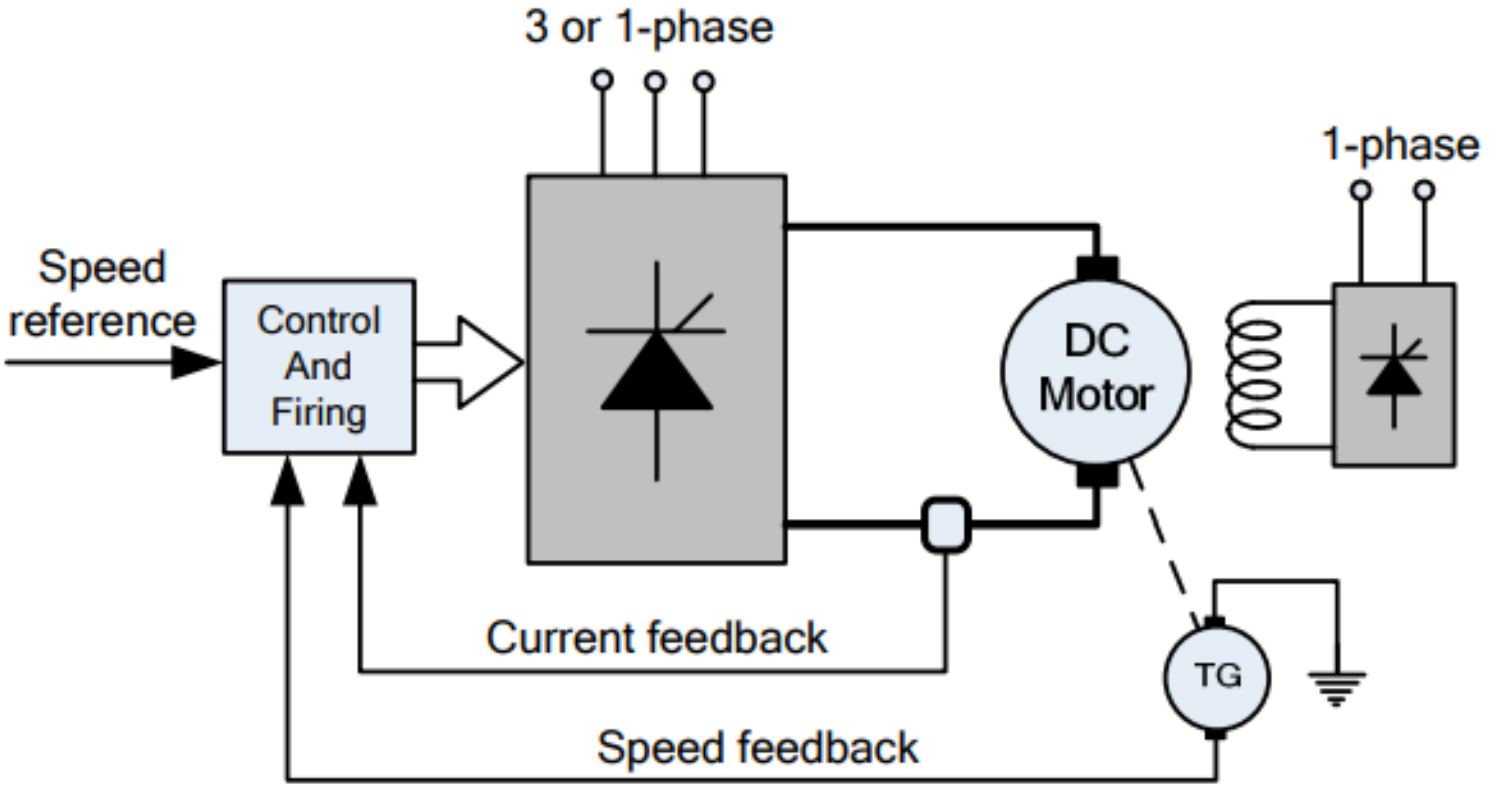
POWER ELECTRONICS CONVERTERS FOR DC DRIVES

- Speed Control Strategy:
  - ✓ below base speed: Va control
  - ✓ above base speed: flux control via Vf control
- Power electronics converters are used to obtain variable voltage
  - ✓ Highly efficient
  - ✓ Ideally lossless
- Type of converter used is depending on voltage source :
  - ✓ AC voltage source --- Controlled Rectifiers
  - ✓ Fixed DC voltage source --- DC-DC converters

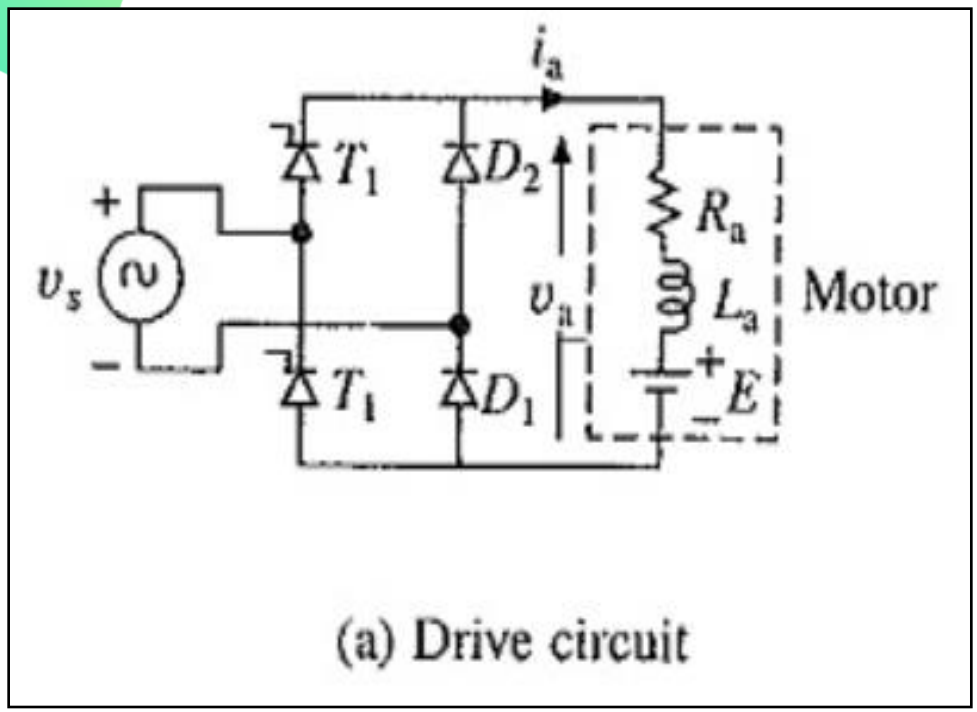
DC DRIVES

- DC motors are still used for wide speed range, starting and accelerating torques more than 400% of their rated values, good speed regulation and simpler and cheaper control systems.
- Modern DC motor drives utilize power electronic devices and are subdivided to chopper-fed and controlled thyristor-fed drives according to the way it manage the energy generated during braking of the DC motor.
- The classification of DC motor drives can be done according to the type of the utilized converter, which controls the speed and the torque of the DC motor.
- When a controlled single-phase or three- phase rectifier is used, then this drive category is called Controlled Rectifier-Fed or Thyristor-Fed DC motor drive. Another DC motor drive category is the Chopper-Fed, in which a DC to DC converter is used.

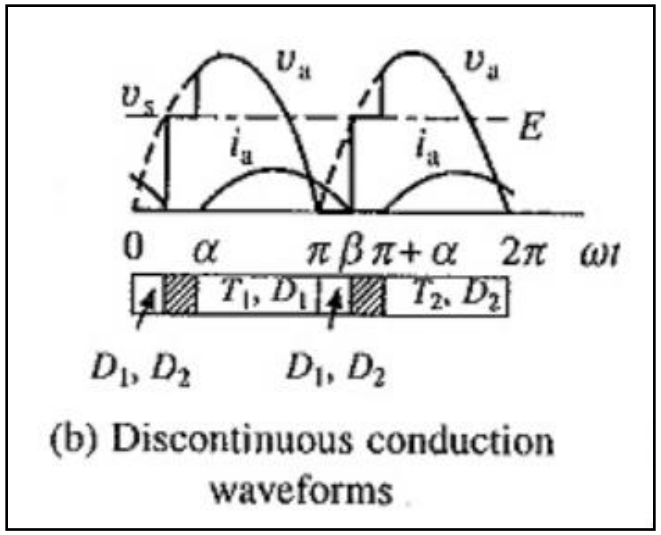
CONTROLLED RECTIFIER-FED DC DRIVES



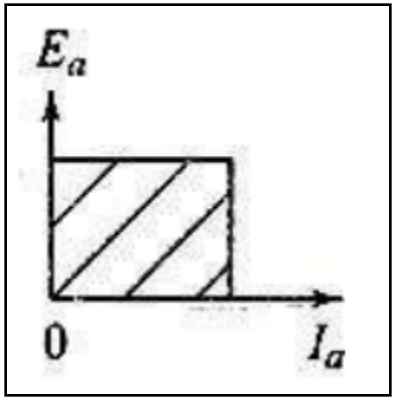
SINGLE PHASE HALF CONTROLLED RECTIFIER CONTROL OF DC MOTOR

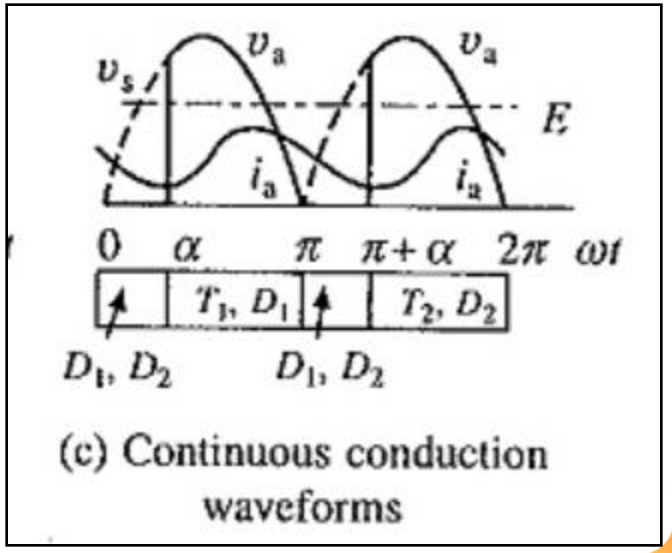


(a) Drive circuit



(b) Discontinuous conduction waveforms



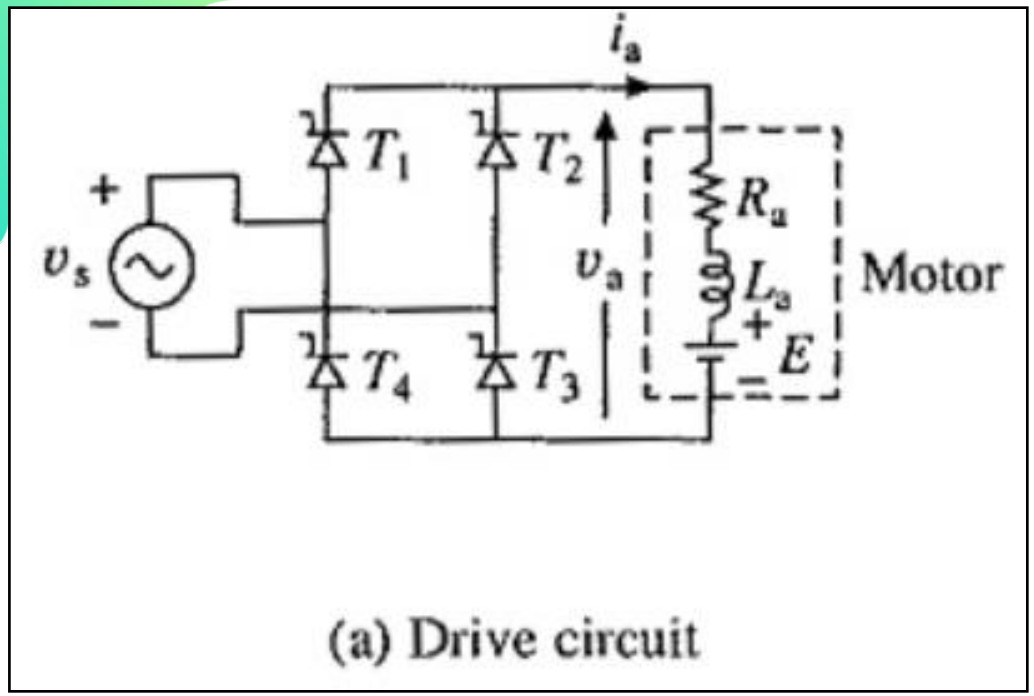


(c) Continuous conduction waveforms

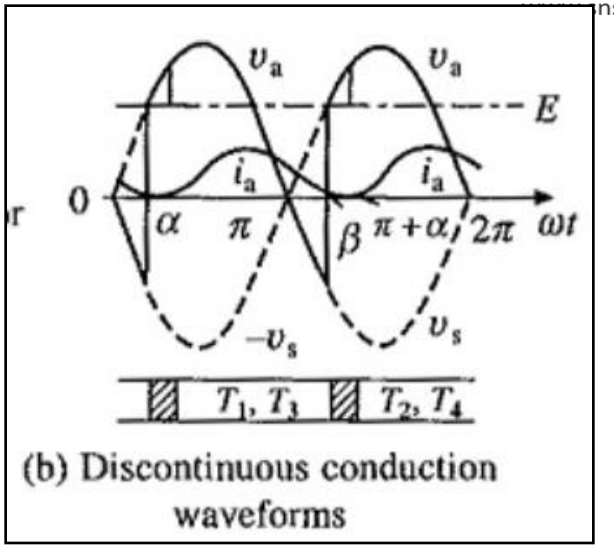
SINGLE PHASE HALF CONTROLLED RECTIFIER CONTROL OF DC MOTOR

- In a cycle of source voltage, T1 receives gate pulse from α to π and T2 from (π+ α) to 2π.
- Motor terminal voltage and current waveforms for the dominant discontinuous and continuous conduction mode are shown respectively.
- In discontinuous conduction mode, when T1 is fired at α, motor gets connected to the source through T1 and D1 and va = vs. The armature current flows and D2 gets forward biased at π.
- Consequently, armature current freewheels through the path formed by D1 and D2, and the motor terminal voltage is zero. Conduction of D2 reverse biases T1 and turns it off. Armature current drops to 0 at β and stays zero until T2 is fired at (π+ α).
- Similarly, the continuous conduction mode can be explained.
- The drive operates in quadrants I (forward motoring) only.

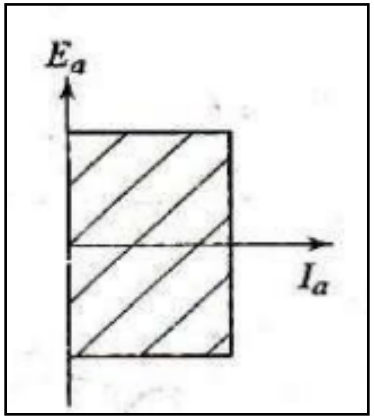
SINGLE PHASE FULLY CONTROLLED RECTIFIER CONTROL OF DC MOTOR

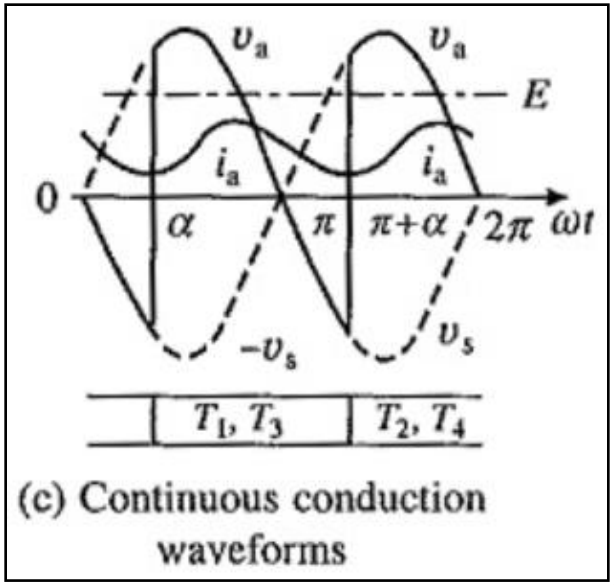


(a) Drive circuit



(b) Discontinuous conduction waveforms





(c) Continuous conduction waveforms

SINGLE PHASE HALF CONTROLLED RECTIFIER CONTROL OF DC MOTOR

- In a cycle of source voltage, thyristors T1 and T3 are given gate signals from α to π, and thyristors T2 and T4 are given gate signals from $(\pi + \alpha)$ to 2π.
- When armature current does not flow continuously, the motor is said to operate in discontinuous conduction. When current flows continuously, the conduction is said to be continuous.
- In discontinuous conduction mode of Single Phase Fully Controlled Rectifier Control of DC Motor, current starts flowing with the turn-on of thyristors T1 and T3 at $\omega t = \alpha$. Motor gets connected to the source and its terminal voltage equals vs. The current, which flows against both, E and the source voltage after $\omega t = \pi$, falls to zero at β.
- Due to the absence of current T1 and T3 turn-off. Motor terminal voltage is now equal to its induced voltage E. When thyristors T2 and T4 are fired at $(\pi + \alpha)$, next cycle of the motor terminal voltage va starts.

SINGLE PHASE HALF CONTROLLED RECTIFIER CONTROL OF DC MOTOR

- In continuous conduction mode of Single Phase Fully Controlled Rectifier Control of DC Motor, a positive current flows through the motor, and T2 and T4 are in conduction just before α.
- Application of gate pulses turns on forward biased thyristors T1 and T3 at α.
- Conduction of T1 and T3 reverse biases T2 and T4 and turns them off.
- A cycle of va is completed when T2 and T4 are turned-on at (π + α) causing turn-off of T1 and T3.
- The drive operates in quadrants I (forward motoring) and IV (reverse regenerative braking).

KEEP
LEARNING.

Thank u

SEE YOU IN NEXT CLASS