EE6351-ELECTRICAL DRIVES AND CONTROLS

UNIT II DRIVE MOTOR CHARACTERISTICS

1).What is back e.m.f in a D.C. Motor? State its expression.

Armature starts rotating, the main flux gets cut by the armature winding and an e.m.f gets induced in the armature. This e.m.f opposes the applied d.c voltage and is called back e.m.f denoted as Eb.

$$Eb = \frac{PNZ}{60A}$$

= Flux per pole

P= Number of poles

N= Speed in rpm

Z=Total armature conductors

A= Number of parallel paths

2) Write the voltage equation of D.C. Motor

V=Eb+IaRa. The back e.m.f is always less than supply voltage (Eb<V). But Ra is very small hence under normal running conditions, the difference between back e.m.f and supply voltage is very small.

4) What are the important characteristics of a d.c.motor?
Torque – Armature current characteristics
Speed – Armature current characteristics
Speed- Torque Characteristics

5) Why series motor is never started on No load?

Under light load or no load as flux is very small, the motor tries to run at dangerously high speed which may damage the motor mechanically. This can be seen from the speed – armature current and the speed- torque characteristics that on low armature current and low torque condition motor shows a tendency to rotate with dangerously high speed.

6) List some application of d.c.shunt motor?
Blowers and fans
Centrifugal and reciprocating pumps
Lathe machine
Machine tools
Milling machines
Drilling machines

7) List some application of d.c.series motor?
Cranes
Hoists, Elevators
Trolleys
Conveyors
Electric Locomotives

8) List some application of d.c.compound motors?
Rolling mills
Punches
Shears
Heavy Planers
Elevators

9) What is synchronous speed?

The speed depends on the supply frequency (f) and the number of poles for which stator winding is wound (P).It is called synchronous speed denoted as Ns and given by

Ns= 120f/P in r.p.m

10) What is rotor conductor and end ring?

The rotor core is cylindrical and slotted on its periphery. The rotor consists of un insulated copper or aluminum bars called rotor conductors. The bars are placed in the slots. These bars are permananently shorted at each end with the help of conducting copper ring is called end ring.

11) Compare Slip ring and squirrel cage motor

Slip Ring Rotor	Squirrel cage Rotor
Rotor consists of a three phase winding similar to the stator winding	Rotor consists of bars which are shorted at the ends with the help of end rings
Construction is complex	Construction is very simple
Resistance can be added externally	As Permanently shorted, external resistance cannot be added
High starting torque can be added	Moderate staring torque which cannot be controlled
Speed control by rotor resistance is possible	Speed control by rotor resistance is not possible
Slip rings and brushes are presented to add external resistance	Slip rings and brushes are absent
Rotor copper losses are high hence efficiency is less	Rotor copper losses are less hence have higher efficiency

12).What is slip?

The difference between the synchronous speed(Ns) and actual speed(N) of the rotor is known as slip speed. The percentage of slip is given by

% slip s =[(Ns -N) / Ns] *100

13) Induction motor as a transformer?

Transformer is a device in which two windings are magnetically coupled and when one winding is excited by a.c. supply of certain frequency, the e.m.f gets induced in the second winding having same frequency as that of supply given given to the first winding. The winding of which supply is given is called primary winding while winding in which e.m.f gets induced is called secondary winding.

14) What is transformation ratio?

K=E2/E1 (or) k=N2/N1

Were E1= Stator e.m.f per phase in volts
E2=Rotor induced e.m.f per phase in volts at start when motor is at standstill.

15).what are the types of Single phase induction motors?
Split phase induction motor
Capacitor start induction motor
Capacitor start capacitor run induction motor
Shaded pole induction motor

16) What are the types of electric braking in D.C.Motors?
Rheostatic or dynamic braking
Plugging
Regenerative braking

17) What is meant by Rheostat or dynamic braking?

Dynamic braking of electric motors occurs when the energy stored in the rotating mass is dissipated in an electrical resistance. This requires the motor to operate as a generator to convert this stored energy into electrical.

18) What is meant by Plugging?

It is one method of braking of induction motor. when phase sequence of supply of the motor running at a speed is reversed, by interchanging connections of any two phases of stator with respect to supply terminals, operation shifts from motoring to plugging region.

19) What is meant by Regenerative Braking?

Regenerative braking occurs when the motor speed exceeds the synchronous speed. In this case, the induction motor would runs as the induction machine is converting the mechanical power into electrical power, which is delivered back to the electrical system. This method of braking is known as regenerative braking.

20) What are the types of electric braking in induction Motors?
Rheostatic or dynamic braking
Plugging
Regenerative braking
D.C.Dynamic braking

21) What are the three regions in the speed –torque characteristics of induction motor?

I.Motoring region (0< s<1)

II.Generating region(s<0)

III.Plugging region (1<s<2)

22) List the advantage of squirrel cage I.M?
Cheaper
Light in weight
Rugged in construction
More efficient
Require less maintenance
Can be operated in dirty and explosive environments

BIG QUESTION

1).Draw and explain the torque –speed characteristics for the DC motors.

2).What is meant by braking. Explain in details.

3).Draw and explain the speed- torque characteristics curve of 3-phase induction motor.

4) Explain single-phase induction motors speed torque curve in details.

5).What are the braking methods available for induction motors and explain in details.\
6) Breaking problems

UNIT - II

Drive motor characteristics

PART - B

(1) Explain speed - torque characteristics of different types of load.

Industrial loads can be classified as

(i) Constant - torque type load

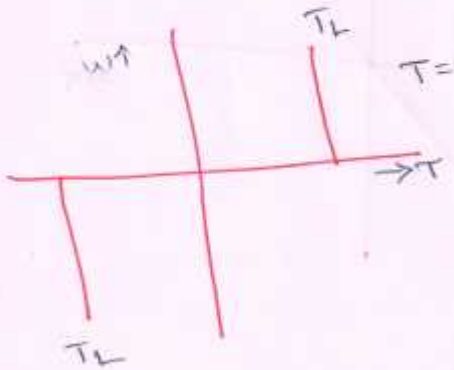
(ii) Torque proportional to speed (generators type)

(iii) Torque proportional to square of speed (fan)

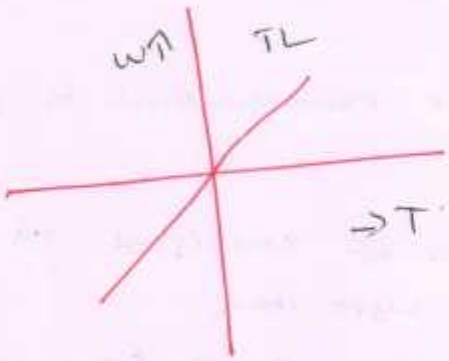
(iv) Torque inversely proportional to speed.

Constant torque characteristics

- Mechanical nature of work like (shaping, cutting & grinding) requires constant torque irrespective of speed.
- Cranes & conveyor handling constant weight of material.
- This type of load exhibit $T = k$.



Torque Proportional to Speed.



eddy current braking & calendering machine have speed torque characteristics.

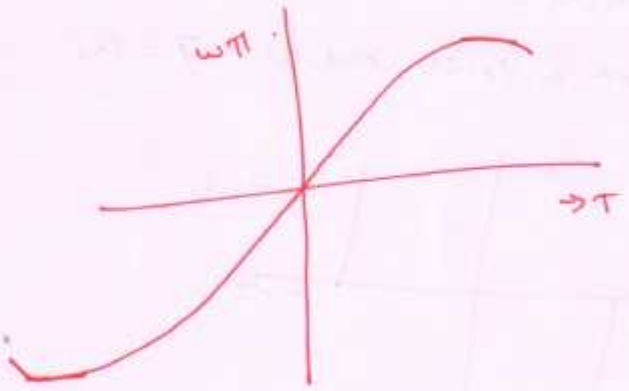
$T \propto N$

$T \propto \omega$

$T = K\omega$

Torque Proportional to Square of Speed.

Fan, rotary pumps, compressors, - This type of load exhibit. $T = K\omega^2$

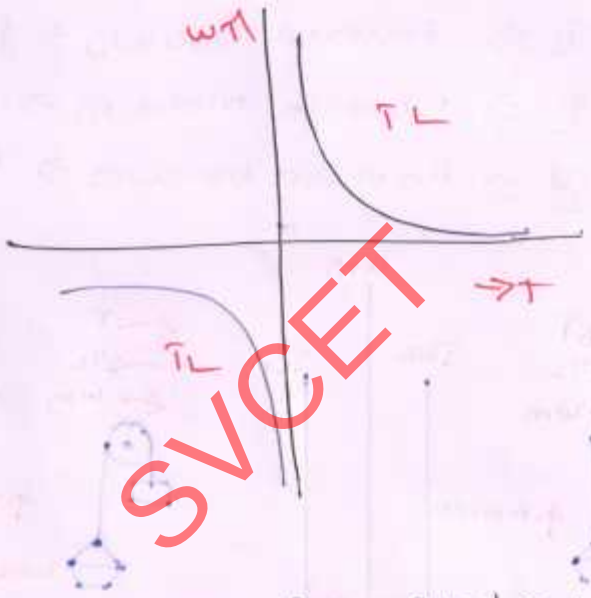


$T \propto \omega^2$

$T = K\omega^2$

Torque inversely proportional to speed.

Certain type of load [lathes, boring machine milling, steel mill coilers exhibit hyperbolic speed torque characteristics. $T = K/\omega$.



$T \propto \frac{1}{\omega}$

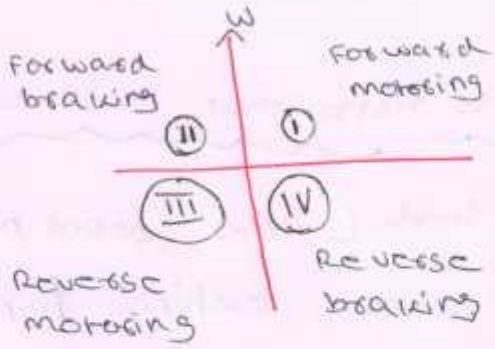
$T = K/\omega$

(2) Explain the four quadrant operation in motor drives.

- A motor operate in two modes motoring & braking for both forward & reverse direction.

motoring ⇒ electrical → mechanical → which supports its motion

braking ⇒ mechanical ⇒ electrical → oppose its motion.

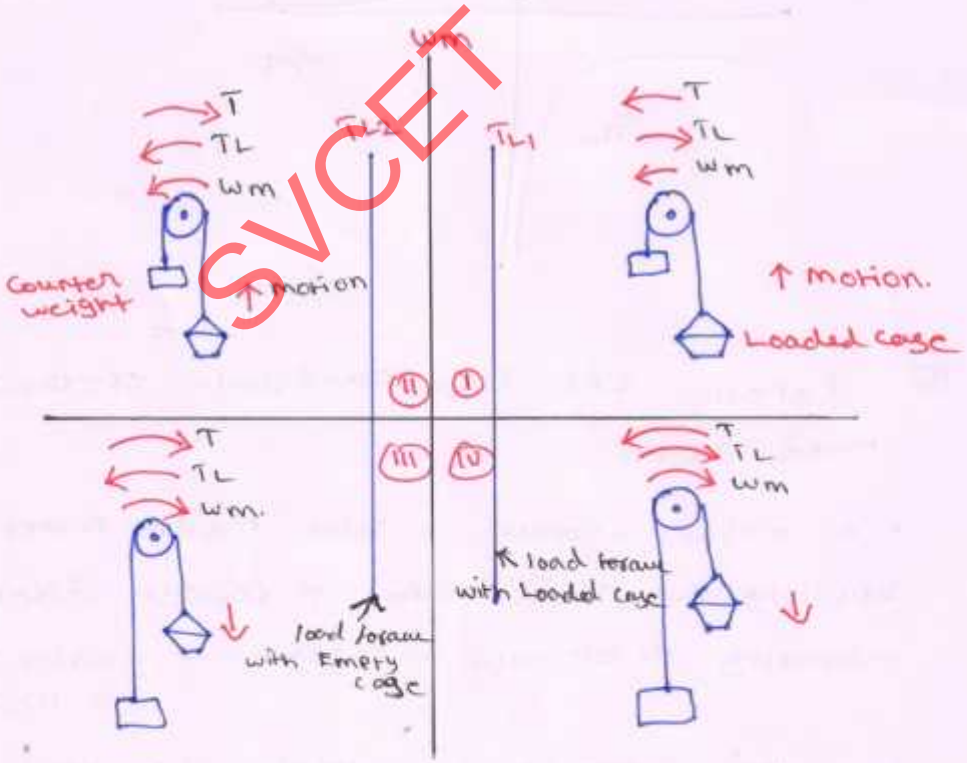


In quadrant I ⇒ forward motoring ⇒ Power +ve

II ⇒ forward braking ⇒ Power -ve

III ⇒ Reverse motoring ⇒ Power +ve

IV ⇒ Reverse braking ⇒ Power -ve



quadrant – I – forward motoring

-> hoist require the movement of cage upward, positive motor speed, CCW direction.

- +ve torque in CCW direction is equal to magnitude of load torque in.
- developed power +ve

quadrant IV reverse braking

weight of loaded cage is higher than that of counter weight. It is able to come down due to gravity.

To limit the speed motor must produce +ve torque.

T can be TL2 in anticlockwise direction.

Power & speed negative

quadrant – II Forward braking

counter weight is heavier than empty cage

In order to limit the speed within safe value motor must produce braking torque equal to TL2 in clockwise direction.

Speed +ve.

Power -ve.

quadrant - III reverse motoring

empty cage is less weight than a counter weight, the motor should produce a torque in clockwise direction.

Speed is -ve

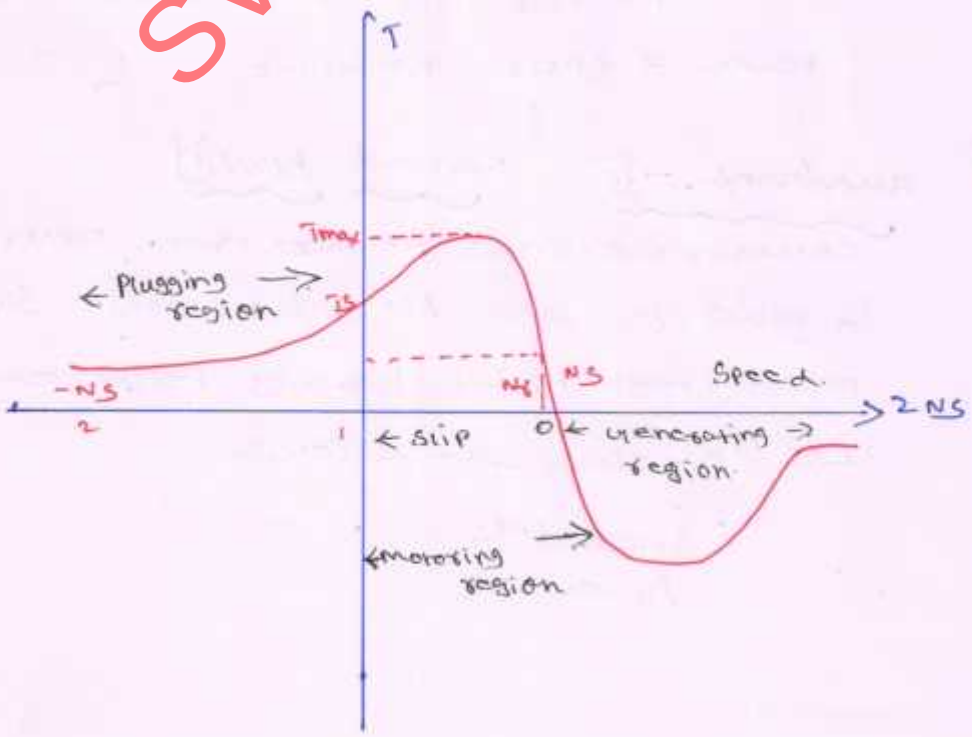
Power is +ve.

(3) Speed-torque characteristics of 3φ- I.M.

(i) motoring $(0 \leq S \leq 1)$

(ii) regenerating $(S < 0)$

(iii) Plugging $(1.0 \leq S \leq 2.0)$



motoring region ($0 \leq S \leq 1$)

- Induction motor rotates same direction of field.

  Speed is decreases, torque increases till breakdown torque after torque decreases & slip increases.

Generating region ($S < 0$)

- machine operates → generator
- rotor rotates at greater than synchronous speed in same direction
- Slip -ve

Plugging region ($1 \leq S \leq 2$)

- Slip becomes greater than unity.
- motor rotates in opposite direction of rotating magnetic field.

  under this condition the machine is quickly come to stop

  If the supply is not disconnected the motor starts to rotate in reverse direction.
- The energy due to plugging torque is dissipated with in machine.

(4) Explain the Concept of braking methods.

(i) Regenerative braking
(ii) Dynamic (or) Rheostatic
(iii) Plugging (or) Reverse Current braking.

Regenerative braking

- The motor operates as a generator, while it is still connected to supply. motor speed is greater than synchronous speed. mechanical energy is converted to electrical energy.

Ex

electric motor is driving a trolley bus in uphill and down hill direction.

- The motor must produce a force fm opposite to Fx to move the bus in uphill direction.
- motor torque & speed are in same direction but load torque is T_L is opposite to motor torque Tm.

Power flow is from the motor to mechanical load.

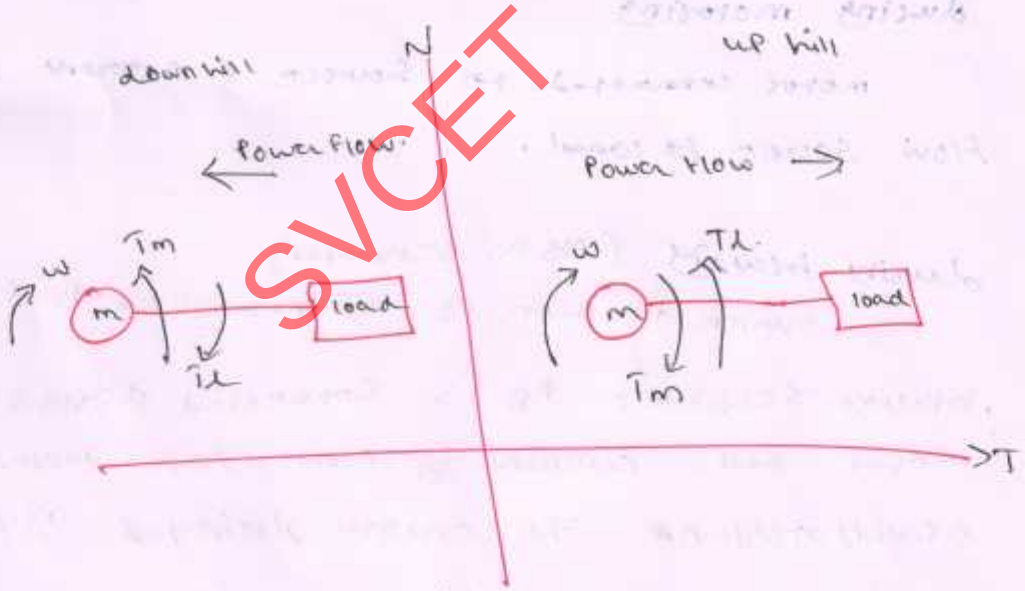
The same bus traveling downhill.

The motor produces a torque in reverse direction because of the direction of motor torque is always opposite to direction of load torque.

- motor torque & speed are in opposite direction.

Tl is opposite to motor torque Tm. The energy exchange under regenerative braking.

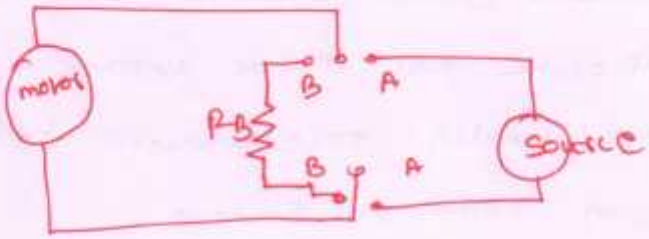
Power flow from load to source.



Dynamic (or) Rheostatic braking

- when an electric motor rotates a kinetic energy is stored in its rotating mass. If the motor is disconnected from the supply it

continues to rotate for a period of time until the kinetic energy is totally dissipated in form of rotational losses. The faster the dissipation of kinetic energy, more rapid braking



during motoring

motor connected to source & current will flow source to load.

during braking (acts as generator)

switch position is connected to B posion.

. braking resistance R_B is connected across the motor. and current I_B flows from motor to braking resistance. The energy dissipated is faster. and motor braking. also easier.

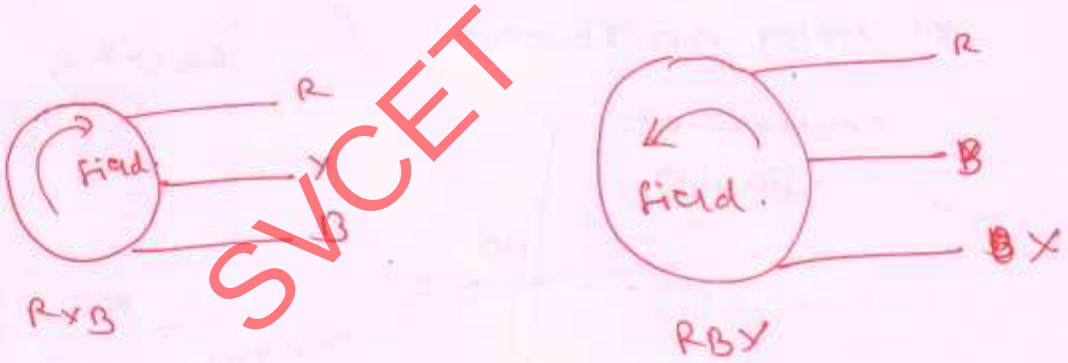
I_B oppose I_A.

Plugging

By interchanging any two supply terminals the braking torque is produced. The direction of rotation of rotating magnetic field is reverse with respect to rotation of motor.

For dc motor → change the supply terminals of armature or field.

For AC motor → RYB sequence.



(5) Explain regenerative braking? How is it achieved in DC motors?

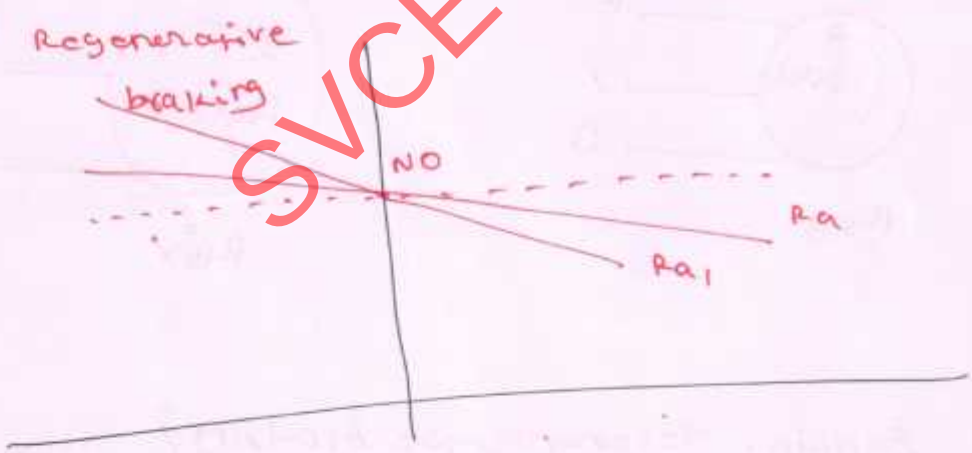
Regenerative braking with return of energy to supply is obtained when under certain condition. The motor is forced to run at a speed of higher than no load speed.

DC Shunt motor

motor operates as a generator connected in parallel with supply and direction of armature current also reverse The energy is returned to supply

$$I_a = \frac{V - E_b}{R_a} = \frac{-E_b - V}{R_a}.$$

Reversal of direction of armature current the motor also reverses.



Advarge

- econimical.

disadvantage

limitedly used.

DC Series motor

For dc Series motor regenerative braking is not possible because reversal of Ia, the direction of field also reverse.

hower used in traction with special arrangement