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Date:
Page: 1

EE160 : Experiment 1

Objectives: • To study the speed control of DC motor by field resistance control. Draw the graph between the armature current and motor speed by varying the field resistance.

• To study the speed control of DC Shunt motor by armature control method. Draw the graph between armature voltage and motor speed by varying the armature voltage.

Theory: We know that the speed of a shunt motor is given by:

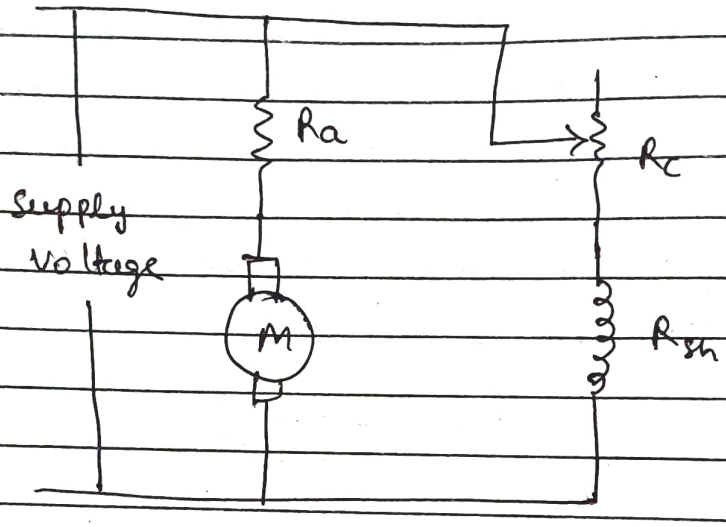
$$N = \frac{(V - I_a R_a)}{K \phi}$$

where, V_a is the voltage applied across the armature and ϕ is the flux per pole and is proportional to the field current, I_f. As explained earlier, armature current I_a is decided by the mechanical load present on the shaft. Therefore by varying V_a and I_f, we can vary N. For fixed supply voltage and the motor connected as shunt, we can vary V_a by controlling an external resistance connected in series with the armature. I_f of course can

be varied by controlling external field resistance R_c connected with the field circuit.

Thus for shunt motor, we have essentially two methods for controlling speed, namely, by

(i) varying armature resistance
(ii) varying field resistance



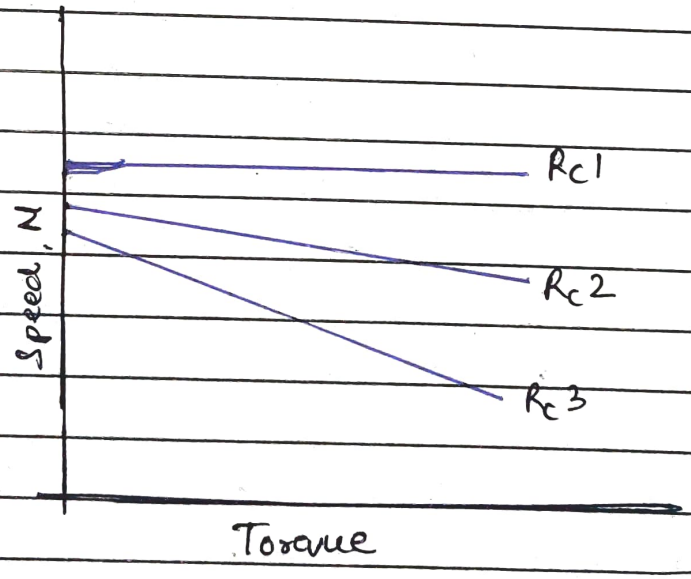
Equivalent circuit for field control of DC motor

- **Speed control by varying field current :-**

In this method, field circuit resistance is varied to control the speed of a d.c. shunt motor. Let us rewrite the basic equation to understand the method.

$$N = \frac{V - I_a R_a}{K \phi}$$

If we vary I_f, flux ϕ will change, hence speed will vary. To change I_f, an external resistance is connected in series with the field windings. The resistance is called the Shunt field regulator. The field coil produces rated flux when no external resistance is connected and rated voltage is applied across field coil. It should be understood that we can only decrease flux from its rated value by adding external resistance. Thus the speed of the motor will rise as we decrease the field current and speed control above the base speed will be achieved. Speed versus armature current characteristic is shown,



Torque Speed characteristic of DC Motors

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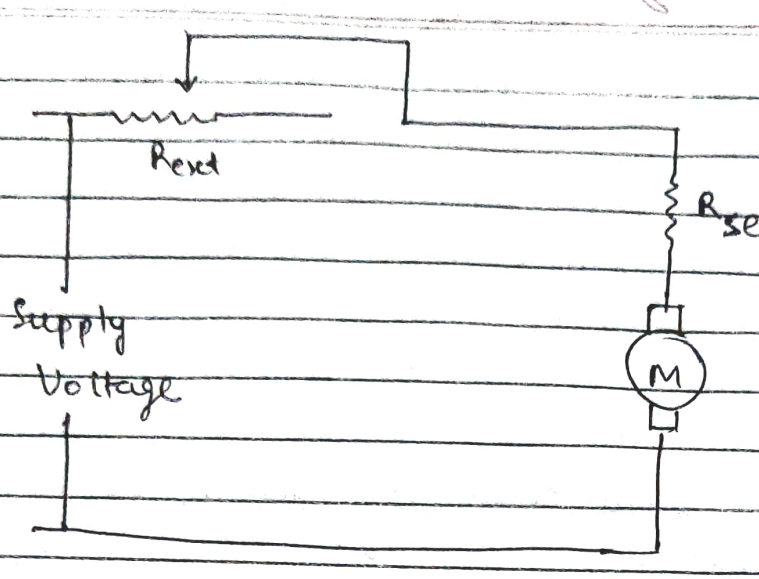

Equivalent Circuit for Armature Control of DC Motor

- Speed control by varying armature resistance

In this method, a variable series resistor Rext is put in the armature circuit. In this case the field is directly connected across the supply and therefore the flux ϕ is not affected by variation of Rext in this case and hence the flux are affected by the variation of the armature circuit resistance. The voltage drop in Rext reduces the voltage applied to the armature and therefore the speed is reducing.

The slope of the N Vs I_a or N Vs Te characteristics can be modified by deliberately connecting external resistance Rext in the armature circuit. One can get a family of speed vs armature curves for various values of Rext. From these characteristics, it can be explained how speed control is achieved. Let us assume that the load torque R_L is

constant and field current is also kept constant. Therefore, since steady operation demands $T_e = T_L$, $T_e = K\phi$ too will remain constant; which means I_a will remain constant. Suppose $R_{ext} = 0$, then at rated load torque, operating point will be at C and motor speed will be N. If external resistance R_{ext_1} is introduced in the armature circuit, the new steady state operating speed will be N_1 corresponding to the operating point D. In this way, one can get a speed of N_2 corresponding to the operating point E, when R_{ext_2} is introduced in the armature circuit. This same load torque is supplied at various speeds. Variation of speed is smooth and speed will decrease smoothly if R_{ext} is increased. Obviously, this method is suitable for controlling speed below the base speed and for supplying constant rated load torque which ensures rated armature current always. Although, this method provides smooth wide range speed control (from base speed to zero speed), it has a serious draw back since energy loss takes place in the external resistance R_{ex} reducing the efficiency of the motor.

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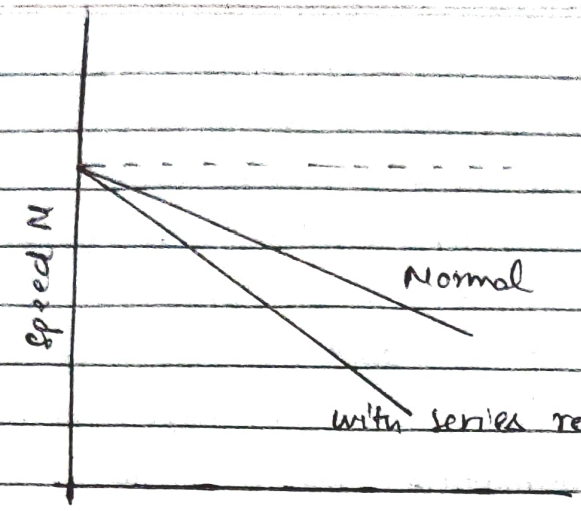
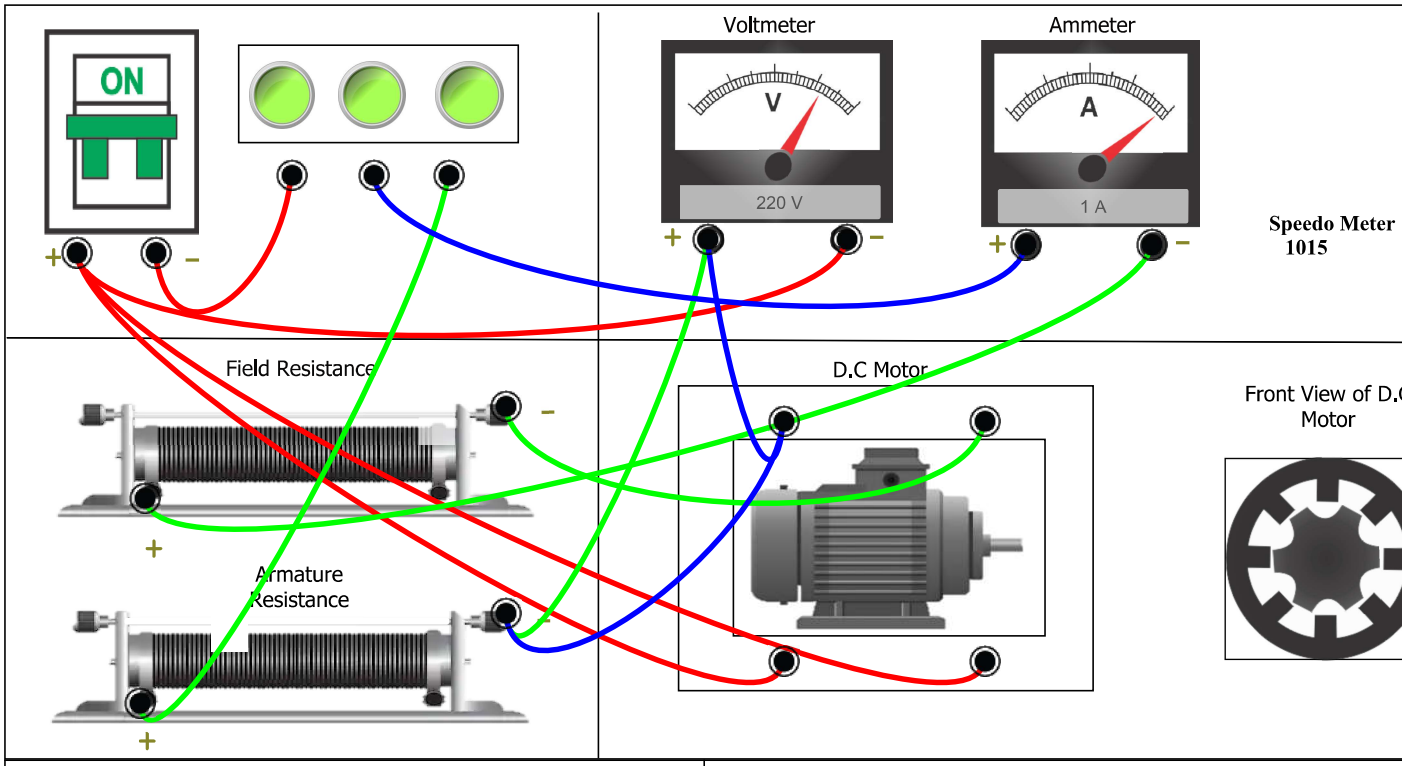


Armature current speed characteristics of DC Motors

Procedure : (a) i) Make proper connection and check it.
ii) set the voltmeter first with the help of second slider
iii) Now, move the ~~point~~ first slider to get corresponding values of ammeter and speedometer.
(iv) Press 'Add to Table'
(v) Plot Graph.

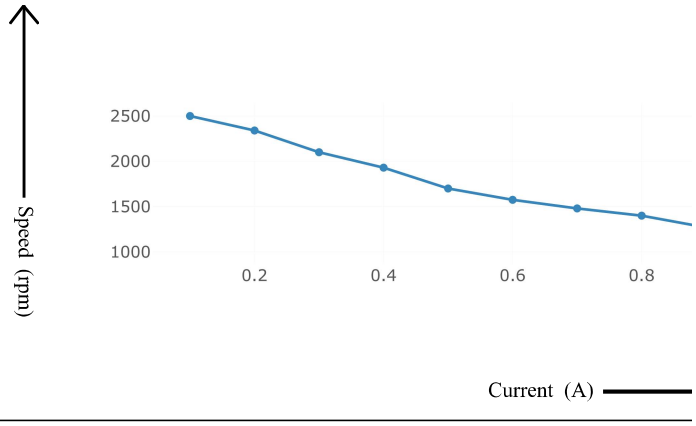
(b) (i) Make proper connections and check it.
(ii) Tap on MCB to turn on the circuit.
(iii) Move second slider to get variation over voltmeter readings.
(iv) Now, move first slider to get coresponding values of ammeter and speedometer.
(v) Press 'Add to Table'
(vi) Plot Graph.

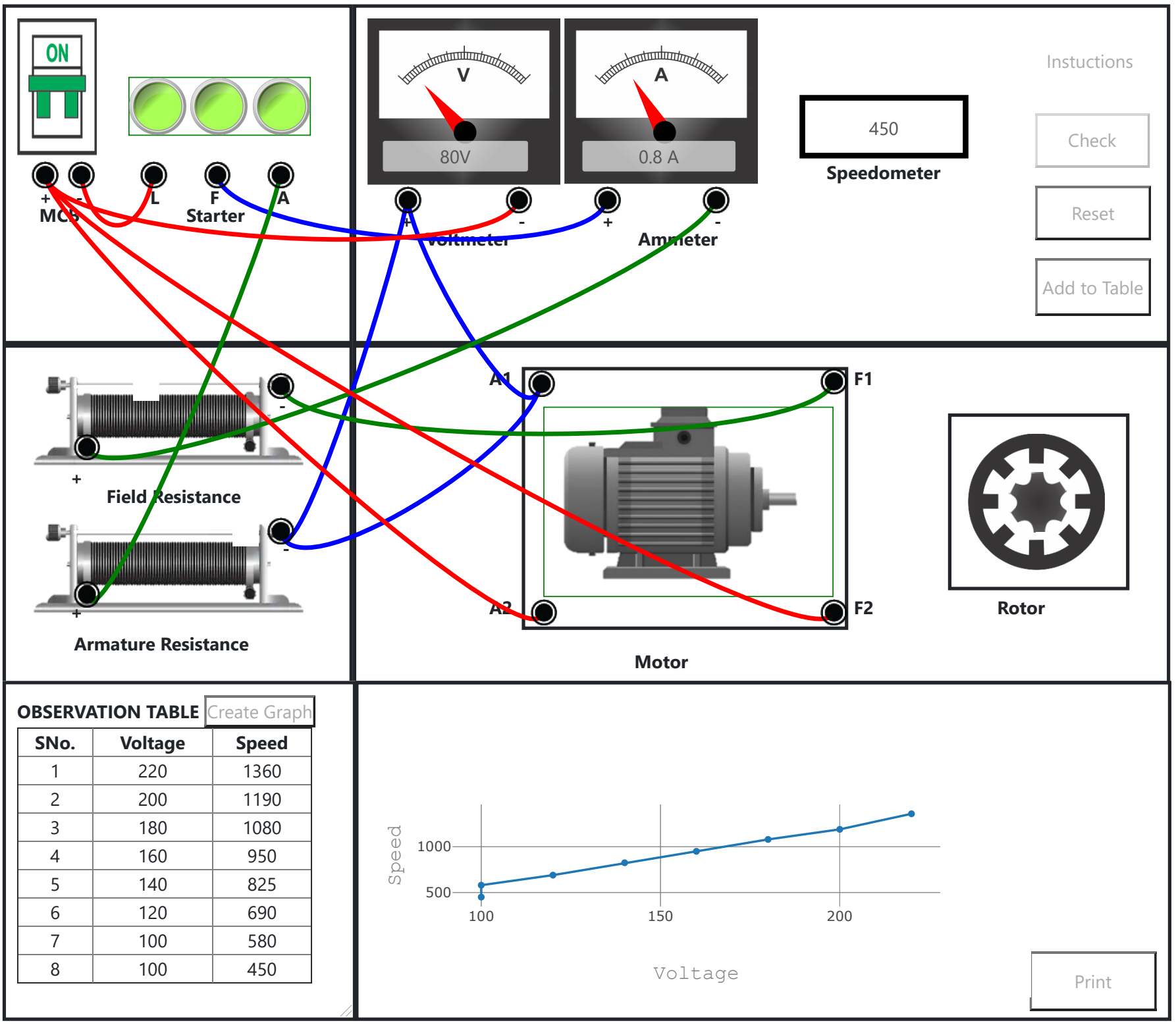
Simulation Results



OBSERVATION TABLE Plot Graph

Current (A)	Speed (rpm)
0.1	2500
0.2	2340
0.3	2100
0.4	1930
0.5	1700
0.6	1575
0.7	1480
0.8	1400
0.9	1270
1	1015





OBSERVATION TABLE Create Graph

SNo.	Voltage	Speed
1	220	1360
2	200	1190
3	180	1080
4	160	950
5	140	825
6	120	690
7	100	580
8	100	450

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Quiz Performance

Speed Control of DC motor by field resistance control

Pre Test

Which torque is greater.....

- (●) a : Breakdown
- ( ) b : Full load
- ( ) c : No-load
- ( ) d : Running

The following motor definitely has a permanent magnet rotor.....

- ( ) a : DC commutator motor
- ( ) b : Brushless dc motor
- (●) c : Stepper motor
- ( ) d : Reluctance motor

To eliminate the fifth harmonic a short-pitched coil should have a short-pitching angle of.....

- (●) a : 36 DEGREE
- ( ) b : 18 DEGREE
- ( ) c : 15 DEGREE
- ( ) d : 12 DEGREE

A full-pitched coil of Ni ampere-turns placed in stator slots causes a fundamental mmf wave of peak amplitude.....

- ( ) a : 4(Ni)/p
- ( ) b : p(Ni)/4
- (●) c : 4(Ni/2)/p
- ( ) d : p(Ni/2)/4

Speed of 3-phase induction motor is controlled from 1to 2pu using a variable frequency inverter. Equivalent circuit parameter to vary is

- ( ) a : stator leakage inductance
- (●) b : rotor leakage inductance
- ( ) c : magnetising inductance

○ d : core loss resistance

Submit Quiz

5 out of 5

Speed Control of DC motor by field resistance control

Post Test

In case of regenerative braking, the motor

- ○ a : Dissipates energy in armature circuit
- ○ b : Dissipates energy in field circuit
- ○ c : Both a and b
- ◉ d : Supply energy to source

If plugging is applied to series motor for a long time, then

- ◉ a : It will start revolving in other direction at low speed
- ○ b : Motor will stop
- ○ c : Motor will burn
- ○ d : None of these

Disadvantage of the field-control method of speed control is

- ○ a : That speed above normal speed can be achieved
- ◉ b : That commutation becomes unsatisfactory
- ○ c : Its low efficiency
- ○ d : None of these

Speed regulation of a d.c. motor can be ideally achieved with

- ○ a : A.C. excitation to the field of the motor
- ○ b : Variable excitation to the field of the motor
- ◉ c : constant excitation to the field of the motor
- ○ d : no excitation to the field of the motor

Disadvantage of ward-Leonard system is

- ○ a : increased maintenance cost
- ○ b : its high initial cost
- ○ c : its low efficiency at light loads
- ◉ d : All of them

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Speed Control of DC motor by Armature Resistance Control

Pre Test

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The following motor definitely has a permanent magnet rotor……

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If the peak value of phase mmf is F (max), the peak value of the rotating field caused by three-phase is……

- ( ) a : F(max)/2
- ( ) b : F(max)
- (●) c : 3F(max)/2
- ( ) d : 3F(max)

In the dc machine the angle between the stator and the rotor field is……

- ( ) a : DEPENDENT UPON THE LOAD
- ( ) b : 45 DEGREE
- (●) c : 90 DEGREE
- ( ) d : 180 DEGREE

Speed Of 3-Phase induction motor is controlled from 1 to 2pu using a variable frequency inverter equivalent circuit parameter to vary is...

- ( ) a : stator leakage inductance
- (●) b : rotor leakage inductance
- ( ) c : magnetising inductance

○ d : cross loss resistance

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Speed Control of DC motor by Armature Resistance Control

Post Test

A 4 pole generator with 16 coil has a two layer lap winding. The pole pitch is

- (●) a : 32
- ( ) b : 16
- ( ) c : 8
- ( ) d : 4

Line joining tangent and Torque line in a circle diagram gives

- ( ) a : Cu loss
- ( ) b : Stator loss
- ( ) c : Maximum output
- (●) d : Maximum Torque

Two electrical wires run to a machine. One wire is 6mm thick, and the other is 3mm thick. For the two wires to carry the same current, the larger wire

- (●) a : Requires less voltage
- ( ) b : Requires more voltage
- ( ) c : Requires the same voltage
- ( ) d : It can not be determined from the information given

Difference in speed between stator field and rotor

- ( ) a : Full load speed
- ( ) b : No load speed
- (●) c : Slip
- ( ) d : Regulation

Shape of the torque slip curve is

- (●) a : Rectangular Hyperbola
- ( ) b : Parabola
- ( ) c : Sine
- ( ) d : Cosine

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