Name : Majid Mahmood
ID : 13876
subject : Electrical Machine
Exam : Summer Final

IQRA International university Peshawar

Question No 1

Part : a

Speed control Method of DC Motor:

Speed control of a DC motor is either done manually by the operator or by means of an automatic control device. This is different to speed regulation. where the speed is trying to be maintained (or regulated) against the natural change in speed due to a change in the load on the shaft.

~~The speed of a DC motor (Nd) is equal to~~

The speed of the DC motor have 3- types.

shunt, series and compound.
It can be controlled by changing the quantities on the right hand side of the below equation:

$= E_b = V - I_a R_a$

$N \propto V - I_a R_a / \phi$

So hence the speed can be varied by changing
(1) The terminal voltage of the armature, V.
(2) The external resistance in armature circuit. R_a.
(3) The flux per pole, ϕ

- Speed control is international change in speed of motor. It is different from concept of speed regulation where there is natural change in speed due to loading and unloading of shaft. Speed change is done manually or by automatically control devices.

EMF Equation:

$E_b = P\phi NZ / 60A$

$N = E_b\, 60A / P\phi Z$

but, for a DC motor A, P and

Z are constants

Therefore, $N \propto K E_b/\phi$ (where, K = const)

This shows the speed of a DC motor is directly proportional to the voltage applied, Armature current and Armature Resistance and inversely proportional to the flux per pole.

Method of speed control of DC series motor

Field Divertor Method:

⇒ In this method, a low value resistance (Diverter) is connected across the field as shown in the below figure [A variable resistor connected in parallel with the series-wound field to control speed is called a diverter]

⇒ By adjusting the diverter resistance, any desired amount of current can be passed through the diverter.

⇒ So the flux can be decreased, consequently the speed of the motor is increased.

⇒ In this method, the speed can be controlled only above normal speed.

→ This method uses a diverter, Here the field flux can be reduced by shunting a portion of motor current around the series field. Lesser the diverter resistance less is the field current, less flux therefore more speed.

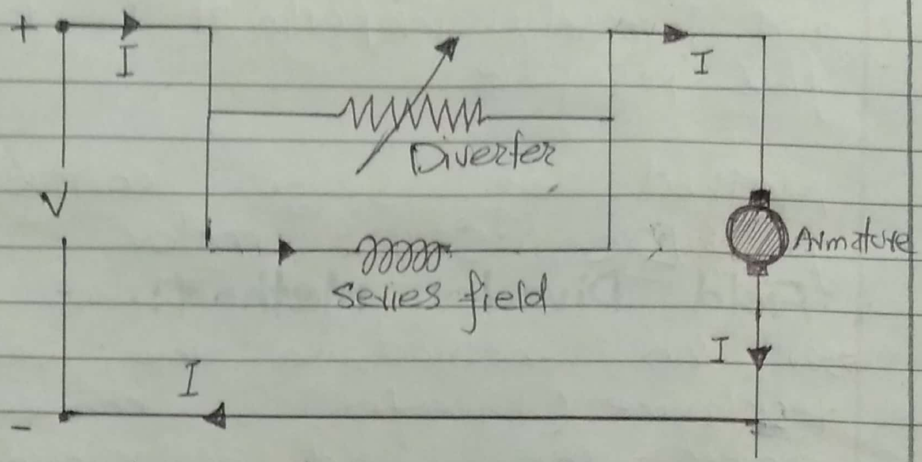


figure: field diverter Method

Speed control of Dc shunt motor:-

In this method, speed variation is accomplished by means of a variable resistance inserted in series with shunt field. An increase is controlling resistances reduces the fied current with a reduction in flux and an increase in speed. This method of speed control is independent of load on the motor.

we Know that the speed of shunt motor is given by

$$N = \frac{Va - ia\,ra}{K\phi}$$

where, Va is the voltage applied across the armature.

N is the rotor speed and ϕ is the flux perpole and is proportional to the field current If. As explained earlier, armature current Ia is decided by the machanical load present on the shaft. Therefore, by varying Va and If we can vary n. For fixed supply voltage and motor conneted as shunt vary by controlling an external resistance connected in series with the armature. If of course can be varied by controlling external field resistance Rf connected with the field circuit. Thus for shunt motor we have essentially two methods for controlling speed, namely by

① varying Armature Resistance
② varying Field Resistance

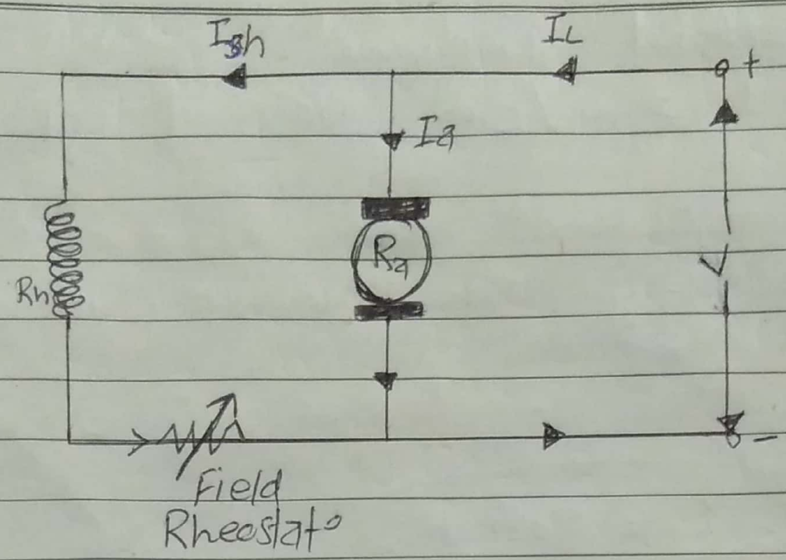
Speed of a shunt Motor:
speed of a ~~shu~~ shunt motor can be changed by.

① Flux control Method
② Armature control Method.
③ ward Leonard system (voltage control method)

Method of speed control of DC shunt motor

Flux control Method:

In this method, the magnetic flux due to the field windings is varied in order to vary the speed of the motor. As the magnetic flux depends on the current flowing through the field winding, it can be varied by varying the current through the field winding.
⇒ In this method, a variable resistance (Known as shunt field rheostat) is placed in series with shunt field winding as shown.
⇒ An increase in controlling resistances reduces the field current with a reduction in flux and in increase in speed.



(i) This is an easy and convenient method.
(ii) It is an inexpensive method since vary little power is wasted in the shunt field rheostat due to velatively small value of Ish.

Question # 1
Part b

Given Data:
In equation for DC generator we Know the following Data.

Number of conductor = Z = 480
emf induced per conductor = 2.2V
Number of poles for DC generate = 8
current per conductor = I_c = 100 A

Finding value:

E = total terminal voltage = ?
I = output current = ?
P_g = Power generation for Lap & wave = ?

Solution:
we Know that A = P for parallel path so
A = 8 according to the given data:
Equation of emf total

emf total = emf induced x $\frac{\text{No. of conductor}}{\text{No. of Poles}}$ → (1)

putting the value in equation (1)
we get

emf total = $2.2 \times \frac{480}{8}$

= 132 V

current Induced = C.I

$C.I = I_c \times$ No. of Poles → (2)

(I_c) = current Per conductor

putting the value in equ (2) we get

$= 100 A \times 8 = 800 A$

$C.I = 800 A$

Power generation

Now we can calculate the Power generation $(P_g) = ?$

$P = V \times I$ → (3)

Putting the value in equ (3) we get.

$P = 800 A \times 132 V$

$P = 105 KW$

EMf for LaP winding

we Know that A = 2

So according to the equ (1) putting the values we get

$emf = 2.2 \times \frac{480}{2}$

$= 528$ ans

Question No 2

(Part a)

Torque and Armature current Relationship:

We know that torque is directly proportional to the product of armature current and field flux, $T_a \propto \phi$.

In DC series motors, field winding is connected in series with the armature, i.e. $I_a = I_f$. Therefore, before magnetic saturation of the field, flux ϕ is directly proportional to I_a.

Equation

$$P_e = P_m$$

P_e = Electric power
P_m = mechanical Power
$P_e = E_a I_a$ as $(E_a = E_b + I_a R_a)$ KVL
$P_e = (E_b + I_a R_a) I_a$
$P_e = E_b I_a + ~~I_a^2 R_a~~$ (as dissipate in form of heat)

$P_e = E_b I_a$

Now

$P_m = T_g W$ :: T_g (Torque in N·M) and W (angular speed in rad/sec)

1 radian = 1 / 2π ∴ In RPM = $N^{*} 2\pi/60$

→ = rad/sec

$P_m = T_g N 2\pi/60$

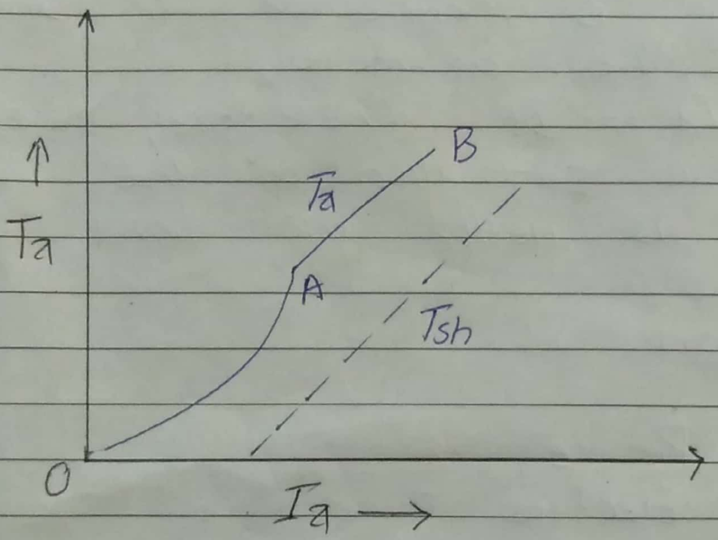
$P_m = p_e$

$T_g N 2\pi/60 = E_b / I_a$ $E_b = \frac{P \cdot \phi \cdot Z \cdot N}{60 \cdot A}$

$T = \frac{P \cdot Z \cdot \phi \cdot I_a}{2 \cdot \pi \cdot A}$

Hence T_g is directly Propositional to I_a.

Figure :-



⇒ Relation between torque and Armature current.

————————————————————

Question No 2

Part : b

	Basis for Comparison	Lap winding	Wave winding
(1)	Defination	The coil is lap back to the succeeding coil	⇒ The coil of the winding form the wave shap.
(2)	Connection	The end of the armature coil is connected to an adjacent segment on the Commutators	⇒ The end of the armature coil is connected to commutator segments some distance apart.
(3)	Parallel Path	The numbers of Parallel Path are equal to the total of number Poles	⇒ The number of Parallel paths is equal to two.
(4)	other Name	Parallel winding or multiple winding	⇒ Two circuit or series winding.
(5)	EMF	Less	More
(6)	Number of Brushes	Equal to the number of parallel path	⇒ Two
(7)	Types	Simplex and Duplex lap winding	⇒ Progressive & Retrogressive wave winding
(8)	Efficiency:	Less	High
(9)	Additional coil	Equalizer Ring	Dummy coil

	Basis for comparison	Lap winding	Wave winding
(10)	winding cost	High (because more conductor is required	⇒ Low.
(11)	uses	In low voltage, High current machine	⇒ In high voltage, low current machines.