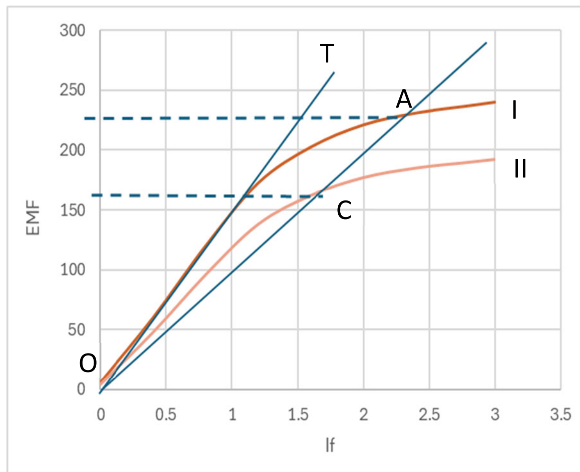
Example 1: The magnetization curve of a DC shunt generator at 1500 r.p.m. is.

I_f (A) :	0	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.0
E_0 (V) :	6	60	120	172.5	202.5	221	231	237	240

For this generator find **(i)** no load EMF for a total shunt field resistance of 100 Ω **(ii)** the critical field resistance at 1500 r.p.m. and **(iii)** the magnetization curve at 1200 r.p.m. and therefrom the open-circuit voltage for a field resistance of 100 Ω



Solution

N_1=1500 rpm (Curve I)

N_2=1200 rpm (Curve II)

Point A (EMF, *If*) at full load

(i) From figure Emf = **227.5 V**

(ii) Rc = 225/1.5=**150 Ω** at 1500 rpm

(iii) $\frac{N_2}{N_1} = \frac{1200}{1500} = \mathbf{0.8}$

The values of these voltages are tabulated below:

$I_f (A)$:	0	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.0
E_0 (V) :	4.8	48	96	138	162	176.8	184.8	189.6	192

Then emf = **166 V** at R_f=**100 Ω**

Example 2: The open-circuit characteristic of a separately-excited DC generator driven at 1000 r.p.m. is as follows:

Field current :	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6
E.M.F. volts :	30.0	55.0	75.0	90.0	100.0	110.0	115.0	120.0

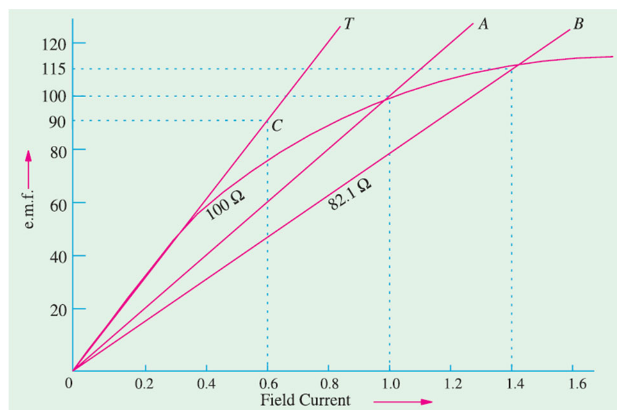
If the machine is connected as shunt generator and driven at 1,000 r.p.m. and has a field resistance of 100 Ω, find

(a) open-circuit voltage and exciting current

(b) the critical resistance and

(c) resistance to induce 115 volts on open circuit.

Solution



(*a*) *O.C.* voltage = **100 V**; Exciting current = **1 A**

(*b*) Line *OT* is tangent to the initial part of the *O.C.C.*

It represents critical resistance. As seen from point *C*,

value of critical resistance is 90/0.6 = **150 Ω**.

(*c*) Line *OB* represents shunt resistance for getting 115 V on open-circuit.

Its resistance = 115/ 1.4 = **82.1 Ω** .

Example 3: A shunt generator gave the following open-circuit characteristic

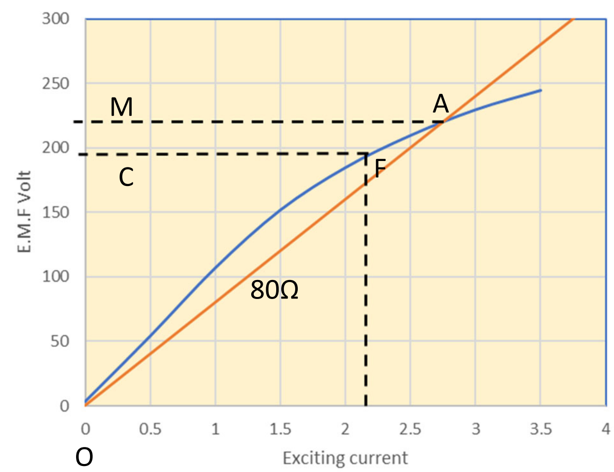
Field current :	0.5	1.0	1.5	2.0	2.5	3.0	3.5 A
O.C. e.m.f. :	54	107	152	185	210	230	245 V

The armature and field resistances are 0.1 Ω and 80 Ω respectively. Calculate

(a) the voltage to which the machine will excite when run as a shunt generator at the same speed. **(b)** The volts lost due to armature reaction when 100 A are passing in the armature at a terminal voltage of 175 V.

Solution

(a) *OA* represents 80 Ω line. The maximum voltage to which the generator will build up is given by OM = **222 V.**



(b) With 175 V terminal on load

I_{sh} = 175/80 = **2.2** A

Voltage corresponding to this field current is given by OC = **195 V**.

Voltage lost due to armature reaction and armature drop = 195 –175 = **20 V**.

Now, armature drop = 0.1 × 100 = **10 V**

Let 'x' be the volts lost due to armature reaction.

Then $10 + x = 20$

x = **10 V**

5 Characteristics of Series Generator

Fig. 7 (i) shows the connections of a series-wound generator. Since there is only one current (that which flows through the whole machine), the load current is the same as the exciting current.

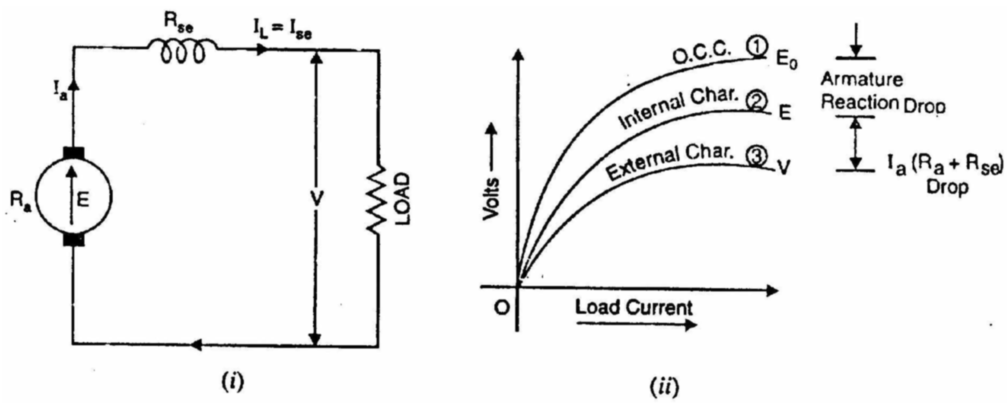


Fig. 7 Characteristics of Series Generator.

5.1 O.C.C.

Curve 1 shows the open circuit characteristic (O.C.C.) of a series generator. It can be obtained experimentally by disconnecting the field winding from the machine and exciting it from a separate DC source.

5.2 Internal characteristic

Curve 2 shows the total or internal characteristic of a series generator. It gives the relation between the generated EMF E. on load and armature current. Due to armature reaction, the flux in the machine will be less than the flux at no load. Hence, EMF E generated under load conditions will be less than the EMF E_0 generated under no load conditions. Consequently, internal characteristic curve lies below the O.C.C. curve; the difference between them representing the effect of armature reaction [See Fig. 7 (ii)].

5.3 External characteristic

Curve 3 shows the external characteristic of a series generator. It gives the relation between terminal voltage and load current I_L.

$$V = E - I_a(R_a + R_{sh})\ volt \qquad (7)$$

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Therefore, external characteristic curve will lie below internal characteristic curve by an amount equal to ohmic drop [i.e., $I_a(R_a + R_{sh})$] in the machine as shown in Fig. 7 (ii).

The internal and external characteristics of a DC series generator can be plotted from one another as shown in Fig. 8. Suppose we are given the internal characteristic of the generator. Let the line OC represent the resistance of the whole machine i.e. $I_a(R_a + R_{sh})$. If the load current is OB, drop in the machine is AB i.e.

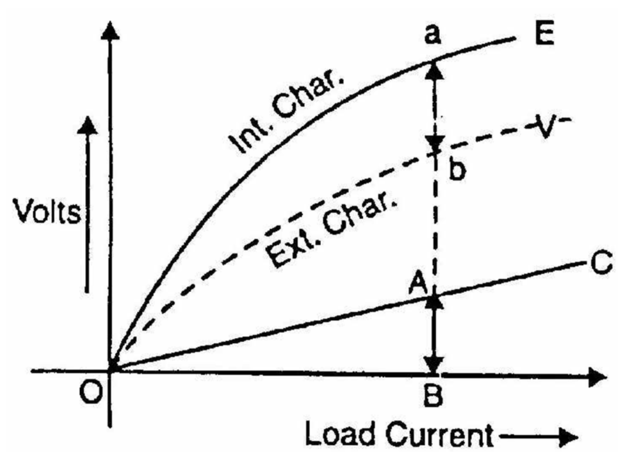

Fig. 8 Internal and External Characteristics of DC Series generator.

AB = Ohmic drop in the machine = OB (($R_a + R_{sh}$) Now raise a perpendicular from point B and mark a point b on this line such that ab = AB. Then point b will lie on the external characteristic of the generator. Following similar procedure, other points of external characteristic can be located. It is easy to see that we can also plot internal characteristics from the external characteristic.

5.4 Critical Resistance for a Series Generator

Fig. 9 shows the voltage build up in a series generator. Here R_1, R_2 etc. represent the total circuit resistance (load resistance and field winding resistance). If the total circuit resistance is R_1, then the series generator will build up a voltage OL.

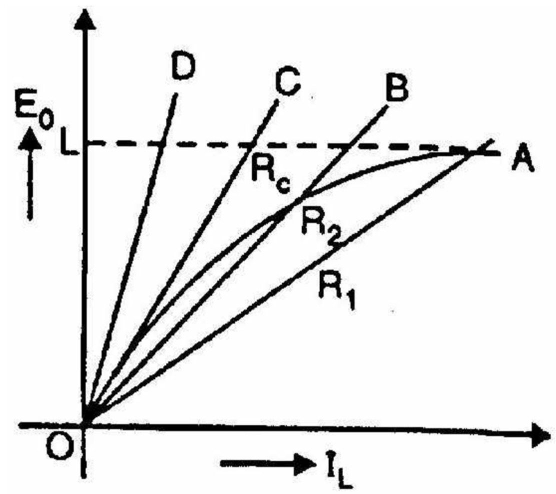

Fig. 9 Critical resistance in series generator.

The line OC is tangent to O.C.C. and represents the critical resistance RC for a series generator. If the total resistance of the circuit is more than RC (say line OD), the generator will fail to build up voltage.