8.17 EXERCISE

The table represents the OCC of a dc machine at 850 rpm. The machine has a shunt field wdg of 600 turns and 20 Ω. The armature circuit resistance is 0.25 Ω.

NB unless otherwise stated, you may neglect the demagnetizing effect of armature reaction and the brush constant drop.

1. Separate excitation

The field wdg is connected in series with a variable resistor to a 330 v separate source.

1.1 The field control resistor (FCR)is set to 10 Ω.

Plot the external characteristic up to a load current of 300 A. find the load current and voltage regulation when the terminal voltage is 220 V. (112 A, 12.7%)

I_f (A)	E (V)
0	20
0.5	24
1	40
2	80
3	119
4	150
5	174
6	193
7	209
8	222
9	233
10	241
11	248
12	253
13	258
14	262
16	268
18	272
20	275

1.2 Repeat 1.1 (on the same sheet) for a FCR of 20. (20 A, 2.3%)

1.3 Find FCR to make the terminal voltage 220 V at a load current of 180 A. (2.3 Ω)

1.4 Find the maximum possible load current at a terminal voltage of 220 V. (196 A)

1.5 Find the terminal voltage when the speed is changed to 1100 rpm, FCR is set to 10 Ω, and the load current is 200 A. (270.9 V)

2. Shunt

2.1 for a speed of 850 rpm:

A. What is the no load voltage when FCR is shorted out? Set to 10 Ω? Set to 30 Ω?

B. Find the critical resistance and short circuit current?

C. What is the critical speed when FCR is set to 10 Ω? 30 Ω?

D. What is the minimum speed at which the generator can build up? (257.5 V, 208 V, 24 V; 40 Ω, 80 A; 637.5 rpm, 1062.5 rpm; 425 rpm)

2.2 for a speed of 1100 rpm:

A. Fined the critical resistance and short circuit current?

B. Find the no load voltage when FCR is shorted out? (51.76 Ω, 103.5 A; 351.5 V)

2.3 At 850 rpm and FCR shorted out:

A. Plot the external characteristic.

B. Find the load current and VR when the terminal voltage is 220 V.

C. Find the terminal voltage, load current and VR when the load resistance is 1.5 Ω.

D. What is the breakdown current?

(101A,17%; 207V, 138A, 24.4%; 291A)

2.4 Estimate the value of FCR needed to make the terminal voltage 220V at a load current of 80A when the speed is 850 rpm. (1.7Ω)

2.5 The speed is 350 rpm and FCR is shorted out. V_b is 2 V, and armature reaction demagnetization is not negligible. Find ΔE and ΔI when the terminal voltage is 220 V at a load current of 56A. (9.25V, 1.3A).

3. **Compound**

The machine is connected in short shunt for cumulative compounding. The speed is 850 rpm.

3.1 With FCR shorted out, it is required to make the terminal voltage 220V when the load current is 150A. how many series turns are needed? What is the voltage regulation? Assume negligible series field resistance. (10 turns, 17%)

3.2 The series field winding has 15 turns and a resistance of 0.05Ω; FCR is shorted out. V_b is 2V and the demagnetizing effect of armature reaction demagnetization is not negligible. when the terminal voltage is 220 V at a load current of 80A. Find the armature current, the induced emf, and ΔE. (91.2A, 259V, 10.2V)

3.3 The series field winding has 16 turns and a resistance of 0.05Ω; FCR is set at some unknown value. V_b is 2V, and the demagnetizing effect of armature reaction is negligible. The load current is found to be 150 A when the shunt field current 10A. Find the terminal voltage, the value of FCR, and VR. (212.5V, 2Ω, 17.6%)

Solution of chapter 8 (EXERCISE 1)

Q1/ Nf=600 R=20Ω R_A=0.25

1) Separate excitation

1-1- F_{CR}=10Ω , I_L=300 I_L=? , V_R=? , At V_t=220V

$R_f=F_{CR}+R_f$ ➡ $R_f=10+20=30\Omega$

$I_f=\frac{vsh}{Rf}=\frac{330}{30}=11A$

E_A= 248, $V_t=E_A-I_AR_A$, $I_A=\frac{EA-Vt}{RA}=\frac{248-220}{0.25}=112A$

$V_R=\frac{Vmt-VAt}{Vfc}=\frac{248-220}{220}*100=12.72\%$

To draw external characteristic

$V_t=E_A-I_AR_A$

I_A=0 ➡ 300 A, $V_t=E_A$=248 when I_A=0

V_t=248-30*0.25=240.5 when I_A=30

I_A	V_t
0	248
30	240.5
60	233
90	225.5
120	218
150	210.5
180	203
210	159.5
300	173

1-2- F_{CR}=20, R_f=40Ω

$I_f=\frac{330}{40}=8.25A$, so E_A=225v

$I_A=\frac{EA-Vt}{RA}=\frac{225-220}{0.25}=20A$

$V_R=\frac{Vnt-Vt}{Vt}=\frac{225-220}{220}*100\%=2.27\approx 2.3\%$

To draw external characteristic

$V_t=E_A-I_AR_A$

$V_t=E_A$=225 when I_A=0

V_t=225-30*0.25=217.5, When I_A=30A

IA	Vt
0	225
30	217.5
60	210
90	202.5
120	195
150	187.5
180	180
210	172.5
240	165
270	157.5
300	150

1-3- FCR=? Vt=220 IA=180A

Vt=EA-IARA

EA=220+180*0.25=265 V, Rf=$\frac{330}{14.78} = 22.3$

FCR=22.3-20=2.3Ω

1-4- Vt=220, Imax ? when, FCR=zero

If=$\frac{Vf}{Rf} = \frac{330}{20} = 16.5$, so EA=269, Vt=EA-IARA, IA=$\frac{EA-Vt}{RA} = \frac{269-220}{0.25} = 196A$

1-5- N=1100Vpm FCR=10Ω IL=200A Vt=?

If=$\frac{Vf}{Rf} = \frac{330}{30} = 11A$, so Ea=248 v at 850 rpm.

$\frac{EA0}{EA1} = \frac{No}{N1} \rightarrow EA1 = \frac{1100*248}{850} = 320.9\,V \quad at \quad 1100Vpm$

Vt=EA-IARA =320.9-200.0.25=270.9 V