Answer All Questions. The solution must include the necessary equations, curves and connections diagrams. (Max. Marks: 50)

1) Give an account about:

# Failure of excitation and re-excitation in self-excited dc generators.
# Comparison between the short-shunt dc generator and long-shunt differential dc motor.
# The unstable ranges in the external characteristic of dc generators.
# Two methods used for speed control of each shunt and series dc motors. (11 Marks)

2) A short-shunt dc motor, 2p=8, 240 V, 70 A, 19 BHP has 200 conductors in the armature. The armature slot contains 4 coil sides, each coil side has 2 conductors. The no load air-gap flux = 0.03 Wb.

\[ R_{f} = 0.2 \, \Omega, \quad R_{s} = 0.1 \, \Omega, \quad R_{f}/\text{pole} = 10 \, \Omega \quad \text{and} \quad R_{g} = 33 \, \Omega. \]

At rated load, the air-gap flux becomes 95% of its value at no load due to the AR effect.

# Find S, C, number of commutator segments and brushes, the type of winding used and its pitches?
# Draw a sketch of the developed diagram of the used winding?
# At rated values, calculate the speed of the motor, the developed torque in kg.m (state its name?), \( P_{ML} \) and efficiency? (Neglect saturation). (12 Marks)

3) The OCC of a separately-excited dc generator at 800 rpm is

<table>
<thead>
<tr>
<th>( I_{f} ) /A</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
<th>1.0</th>
<th>1.2</th>
<th>1.4</th>
<th>1.6</th>
<th>1.8</th>
<th>2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>( E / V )</td>
<td>150</td>
<td>220</td>
<td>250</td>
<td>265</td>
<td>275</td>
<td>282</td>
<td>290</td>
<td>295</td>
<td>300</td>
</tr>
</tbody>
</table>

If the generator feeds a load at 1000 rpm, obtain its OCC and draw it only?
The generator is excited from 225 V mains and has \( R_{a} = 0.2 \, \Omega, \quad R_{f} = 125 \, \Omega \).

At the speed 1000 rpm and \( I_{f} = 100 \, A \), the AR reduces the induced emf by 22 V. Find the load voltage, load resistance and draw the load line.

At 1000 rpm and the load current = 70 A, calculate the load voltage regulation and the developed torque in kg.m. (state its name). (9 Marks)
4) A 100 V, 1500 rpm shunt dc generator has OCC as

<table>
<thead>
<tr>
<th>I_f / A</th>
<th>0</th>
<th>0.5</th>
<th>1.0</th>
<th>1.5</th>
<th>2.0</th>
<th>2.5</th>
<th>3.0</th>
<th>3.5</th>
<th>4.0</th>
<th>4.5</th>
<th>5.0</th>
<th>5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>E / V</td>
<td>3</td>
<td>22.5</td>
<td>45</td>
<td>67.5</td>
<td>88</td>
<td>100</td>
<td>108</td>
<td>113</td>
<td>116</td>
<td>118</td>
<td>120</td>
<td>122</td>
</tr>
</tbody>
</table>

The OC voltage = 120 V and \( R_a = 0.2 \, \Omega \).
At full-load, the voltage drop due AR equals 5 V.
Calculate \( R_f \) and the short circuit current?
Find \( I_a \) at full-load and the load resistance?
Find the voltage regulation at half full-load armature current?
Calculate the critical resistance of the shunt field circuit at 1500 rpm and also the critical speed? (9 Marks)

5) A 9 HP, 220 V, 35 A, 300 rpm dc series motor has \( R_a = 0.1 \, \Omega \) and \( R_f = 0.05 \, \Omega \).
Find at full-load the \( P_{ML} \) and output torque in N.m.
At constant supply voltage, a diverter resistance of 0.08 \( \Omega \) is used. The developed torque becomes 0.75 of its full-load value. Calculate the new value of the armature current and speed, then find the efficiency. Take \( P_{ML} \) as \( N \).
( Neglect AR and saturation ) (9 marks)

Prof. Hassan I. Abou-faddan

End of Questions