Prerequisite 3: Assignment

Comprehensive Electrical Engineering Fundamentals

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Problem Statement:

As an electrical engineer in a power generation facility, you're tasked with analyzing and optimizing the performance of electric machines and generators. Your responsibilities include calculating various parameters related to slip in induction machines, synchronous speed, power output of synchronous generators, losses in electric machines, and DC machine speed.

Tasks to be Performed:

1. Slip in Induction Machines

Given:
Synchronous speed (Ns) = 1800 rpm
Rotor speed (Nr) = 1700 rpm

Solution:
Formula:
Slip = (Ns - Nr / Ns) * 100%
= (1800-1700) / 1800) * 100%
= (100/1800) * 100%
= 5.55%

Therefore, the slip of the electric motor is **5.55%.**

2. Synchronous Speed (Ns)

Given:
Frequency (f) = 60 Hz
Number of poles (p) = 4

Solution:
Formula:
Ns = 120 * (f/p)
= 120 * (60/4)
= 1800 rpm

The synchronous speed is **1800 rpm.**

3. Power output of a Synchronous Generator

Given:
Voltage across terminals (V) = 480 V
Current flowing through the machine (I) = 100 A
Phase angle difference (θ) = 30 degrees
Calculate the real power output of the synchronous generator.

Solution:
Formula:
$P = V I \cos(\theta)$
$= 480*100*\cos(30)$
$= 41{,}570$ Watts.

So, the real power output of the synchronous generator is **41,570 watts.**

4. Copper Loss

Given:
Current through the conductor (I) = 50 A
Resistance of the conductor (R) = 0.2 Ω

Calculate the copper loss in the conductor.

Solution:
Formula:
$P = I^2 * R$
$= (50)^2*0.2$
$= 500$ Watts.

The copper loss in the copper wire is **2.5 watts.**

5. Iron Loss

Given:
Hysteresis loss (Ph) = 500 W
Eddy current loss (Pe) = 300 W

Calculate the total iron loss in the machine.

Solution:
Formula:
$P_i = P_h + P_e$
$= 500+300$
$= 800$ Watts

So, the total iron loss in the transformer is **800 watts.**

6. Mechanical Loss

Given:
Friction loss (PFriction) = 200 W
Windage loss (Pwindage) = 150 W

Calculate the total mechanical loss in the machine

Solution:
Formula:
Pmechanical = Pfriction +Pwindage
= 200+150
= 350 Watts

So, the total mechanical loss in the motor is **350 watts.**

7. DC Machine Speed

Given:
Applied voltage to the armature (V) = 240 V
Armature current (Ia) = 50 A
Armature resistance (Ra) = 0.1 Ω
Constant (K) = 0.02
Flux produced by the field winding (Φ) = 0.04 Wb

Calculate the speed of the DC machine.

Solution:
Formula:
N = (V - Ia * Ra) / (K * Φ)
= (240-(50*0.1)) / (0.02*0.04)
= (240-5) / (8*10^-4)
=293750 rpm

So, the speed of the DC machine is **293750** revolutions per minute (RPM).

8. Armature Voltage Control

Given:
Back electromotive force generated by the motor (E) = 220 V
Armature current (Ia) = 60 A
Armature resistance (Ra) = 0.05 Ω

Calculate the armature voltage.

Solution:
Formula:
Va = E + Ia * Ra
= 220+(60*0.05)
= 220+3
=223 V

So, the Armature voltage is **223 V.**