



## **Prerequisite 3 : Assignment Comprehensive Electrical Engineering Fundamentals**

## 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 ( $N_s$ ) = 1800 rpm
- Rotor speed ( $N_r$ ) = 1700 rpm

Calculate the slip in the induction machine.

### 2. Synchronous Speed ( $N_s$ ):

Given:

- Frequency ( $f$ ) = 60 Hz
- Number of poles ( $p$ ) = 4

Calculate the synchronous speed of the machine.

### 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 ( $\theta$ ) = 30 degrees

Calculate the real power output of the synchronous generator.

### 4. Copper loss:

Given:

- Current through the conductor ( $I$ ) = 50 A
- Resistance of the conductor ( $R$ ) = 0.2  $\Omega$

Calculate the copper loss in the conductor.

**5. Iron loss:**

Given:

- Hysteresis loss ( $P_h$ ) = 500 W
- Eddy current loss ( $P_e$ ) = 300 W

Calculate the total iron loss in the machine.

**6. Mechanical loss:**

Given:

- Friction loss ( $P_{\text{Friction}}$ ) = 200 W
- Windage loss ( $P_{\text{windage}}$ ) = 150 W

Calculate the total mechanical loss in the machine.

**7. DC Machine Speed:**

Given:

- Applied voltage to the armature ( $V$ ) = 240 V
- Armature current ( $I_a$ ) = 50 A
- Armature resistance ( $R_a$ ) = 0.1  $\Omega$
- Constant ( $K$ ) = 0.02
- Flux produced by the field winding ( $\Phi$ ) = 0.04 Wb

Calculate the speed of the DC machine.

**8. Armature voltage control:**

Given:

- Back electromotive force generated by the motor ( $E$ ) = 220 V
- Armature current ( $I_a$ ) = 60 A
- Armature resistance ( $R_a$ ) = 0.05  $\Omega$

Calculate the armature voltage.