MATLAB SIMULATION LABS

Single Phase Induction Motors

Lab 1: Introduction and No-Load Test

Objective: To familiarize students with the single-phase induction motor model and determine its no-load characteristics using MATLAB Simulink.
Theory: At no-load, the motor mainly draws magnetizing current and small active current to overcome losses. The equivalent circuit can be used to simulate current, voltage, and input power.
Procedure:
- Open MATLAB → Simulink Library → Simscape → Electrical → Specialized Power Systems.
- Build a model using: Single-phase AC source, Induction Motor (single-phase block), and Measurement blocks for voltage, current, speed, and torque.
- Run simulation for different supply voltages (100–250 V).
- Observe current and power factor variation.
Analysis: Plot supply voltage vs current and discuss the magnetizing effect.

Lab 2: Equivalent Circuit and Parameter Estimation

Objective: To determine equivalent circuit parameters from no-load and blocked rotor tests using MATLAB.

Procedure:

- Use two test data sets: No-load test (V, I, P) and Blocked-rotor test (V, I, P).
- Write a MATLAB script to calculate: $R1 + R2' = Pbr / Ibr^2$ and $X1 + X2' = \sqrt{((Vbr/Ibr)^2 - (R1 + R2')^2)}$.
- Display the computed equivalent circuit.

Analysis: Compare results with typical manufacturer data.

Lab 3: Torque-Speed Characteristics

Objective: To simulate torque–speed characteristics of a single-phase induction motor.
Procedure:
- Use Single-Phase Induction Motor block in Simulink.
- Set: V = 220 V, f = 50 Hz, Stator resistance = 5 Ω, rotor resistance = 3 Ω.
- Add a Mechanical Load Torque block.
- Simulate for varying load torques.
- Plot torque vs speed.

Analysis: Identify starting torque, maximum torque, and operating region.

Lab 4: Capacitor-Start Motor Simulation

Objective: To simulate a capacitor-start single-phase induction motor and study the effect of capacitance on starting torque.
Procedure:
- Use Split-Phase Induction Motor model.
- Connect different capacitor values (50 µF, 100 µF, 150 µF).
- Simulate starting characteristics for each case.
- Record starting torque and current.
Analysis: Plot starting torque vs capacitance and discuss the optimal capacitor value for maximum starting torque.

Lab 5: Performance under Variable Load

Objective: To analyze the performance of a single-phase induction motor under varying mechanical loads.
Procedure:
- Keep supply voltage constant.
- Apply load torque from 0 Nm to rated value in increments.
- Measure speed, torque, current, efficiency, and power factor.
Analysis: Plot load torque vs efficiency and torque vs speed.

Lab 6: Speed Control by Voltage Variation

Objective: To control the speed of a single-phase induction motor by varying supply voltage using MATLAB Simulink.

Procedure:

- Add a Voltage Source with adjustable amplitude.
- Simulate motor speed for V = 150, 200, and 250 V.
- Record speed and torque.

Analysis: Plot speed vs voltage and discuss performance degradation at low voltage.

Lab 7: Harmonic and Power Quality Analysis

Objective: To investigate the impact of harmonics on single-phase induction motor performance.
Procedure:
- Apply a non-sinusoidal supply waveform using PWM inverter model.
- Analyze input current waveform and Total Harmonic Distortion (THD).
- Use FFT Analysis block to calculate THD.
Analysis: Discuss the effect of harmonics on torque pulsation and motor heating.