%% PWM Rectifier Working Analysis in MATLAB

% This code simulates a three-phase PWM rectifier and analyzes its behavior

% including PWM signals, input phase current, and output power

clear all;

close all;

clc;

%% Parameters

fsw = 1e3; % Switching frequency (Hz)

Vdc = 400; % DC link voltage (V)

Vin\_rms = 230; % Input phase voltage (rms) (V)

Rload = 10; % Load resistance (Ohm)

Lfilter = 1e-3; % Filter inductance (H)

Cfilter = 100e-6; % Filter capacitance (F)

%% Derived Parameters

Vline = Vin\_rms \* sqrt(3); % Input line voltage (V)

Vphase = Vin\_rms; % Input phase voltage (V)

m = Vdc / Vphase; % Modulation index

Idc = Vline / (sqrt(3) \* Rload); % DC link current (A)

%% Time vector for simulation

T = 0.01; % Total simulation time (s)

fs = 100\*fsw; % Sampling frequency (Hz)

dt = 1/fs; % Time step (s)

t = 0:dt:T; % Time vector (s)

%% Initialize arrays for simulation results

PWM1 = zeros(size(t)); % PWM signal for Phase 1

PWM2 = zeros(size(t)); % PWM signal for Phase 2

PWM3 = zeros(size(t)); % PWM signal for Phase 3

Iac = zeros(size(t)); % Input phase current (A)

Pout = zeros(size(t)); % Output power (W)

%% Simulate the rectifier

for i = 1:numel(t)

% Calculate the duty cycles for PWM signals

if mod(t(i), 1/fsw) < m / fsw

PWM1(i) = 1;

PWM2(i) = 1;

PWM3(i) = 1;

else

PWM1(i) = 0;

PWM2(i) = 0;

PWM3(i) = 0;

end

% Calculate the input phase current

Iac(i) = sqrt(2/3) \* Idc \* sin(2\*pi\*fsw\*t(i));

% Calculate the output power

Pout(i) = Vphase \* Iac(i) \* PWM1(i);

end

%% Display simulation results

fprintf('Simulation Parameters:\n');

fprintf('Switching Frequency: %.2f Hz\n', fsw);

fprintf('DC Link Voltage: %.2f V\n', Vdc);

fprintf('Input Phase Voltage (rms): %.2f V\n', Vin\_rms);

fprintf('Load Resistance: %.2f Ohm\n', Rload);

fprintf('Filter Inductance: %.2e H\n', Lfilter);

fprintf('Filter Capacitance: %.2e F\n', Cfilter);

fprintf('Modulation Index: %.4f\n', m);

fprintf('Input Line Voltage: %.2f V\n', Vline);

fprintf('Input Phase Voltage: %.2f V\n', Vphase);

fprintf('DC Link Current: %.2f A\n', Idc);

%% Plot simulation results

figure;

subplot(3,1,1);

plot(t, PWM1, 'b', t, PWM2, 'r', t, PWM3, 'g');

xlabel('Time (s)');

ylabel('PWM Signal');

legend('Phase 1', 'Phase 2', 'Phase 3');

title('PWM Signals');

grid on;

subplot(3,1,2);

plot(t, Iac, 'k', 'LineWidth', 1.5);

xlabel('Time (s)');

ylabel('Input Phase Current (A)');

title('Input Phase Current Waveform');

grid on;

subplot(3,1,3);

plot(t, Pout, 'm', 'LineWidth', 1.5);

xlabel('Time (s)');

ylabel('Output Power (W)');

title('Output Power Waveform');

grid on;

%% Calculate and display performance metrics

avg\_power = mean(Pout);

max\_power = max(Pout);

min\_power = min(Pout);

rms\_current = sqrt(mean(Iac.^2));

fprintf('\nPerformance Metrics:\n');

fprintf('Average Output Power: %.2f W\n', avg\_power);

fprintf('Maximum Output Power: %.2f W\n', max\_power);

fprintf('Minimum Output Power: %.2f W\n', min\_power);

fprintf('RMS Input Current: %.2f A\n', rms\_current);