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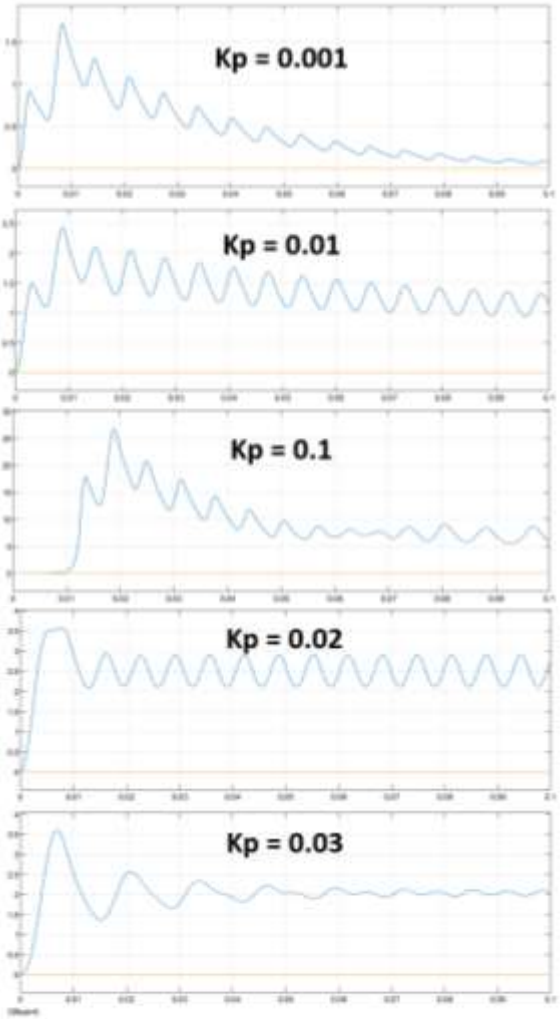
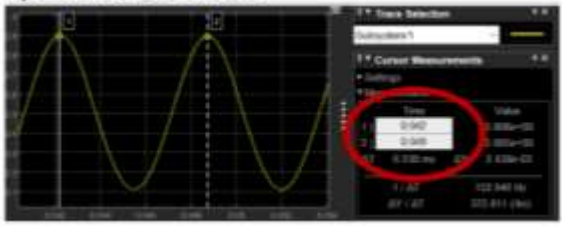
LAMPIRAN

Lampiran A. Proses Pencarian Nilai Ku dan Tu pada Metode ZN



Kp = 0.02, Tu = 0.007



Lampiran B. Program Algoritma Metode GA

```
clc

% Inisialisasi nilai awal
populationSize = 50;
nGen = 2;
lb = [0 0];
ub = [1 1];
population = lb + (ub - lb) .* rand(populationSize, nGen);
maxGenerations = 8;
bestError = zeros(maxGenerations, 1);
error = zeros(populationSize, 1);

generation = 1;
while generation <= maxGenerations
    % Evaluasi error/performa masing-masing kromosom/individu
    for i = 1:populationSize
        error(i) = calculateError(population(i, :));
    end

    % Seleksi parents menggunakan seleksi turnamen
    parentIndex = selectionTournament(error, 18, populationSize);
    parents = population(parentIndex, :);

    % Operasi crossover titik potong tunggal
    offspring = crossover(parents, parentIndex, nGen);

    % Operasi mutasi
    mutationProbability = 0.1;
    mutatedOffspring = mutation(offspring, mutationProbability);

    % Evaluasi error/performa individu/kromosom hasil reproduksi
    offspringError = zeros(size(offspring, 1), 1);
    for i = 1:size(offspring, 1)
        offspringError(i) = calculateError(mutatedOffspring(i, :));
    end

    % Penggantian populasi
    [population, error] = replace(population, error, parentIndex,
offspring, offspringError, populationSize);

    % Pencatatan nilai error terbaik setiap generasi
    bestError(generation) = min(error);

    % Tampilkan hasil setiap generasi
    disp(['Generasi: ', num2str(generation), ' | Error Terbaik
Sementara: ', num2str(bestError(generation))]);

    generation = generation + 1;
end

% Hasil optimasi
[minError, minIndex] = min(error);
```

```
bestParameters = population(minIndex, :);
disp('Hasil Optimisasi:');
disp(['Parameter Terbaik: ', num2str(bestParameters)]);
disp(['Error Terbaik: ', num2str(minError)]);

% Fungsi untuk menghitung performa sistem kontrol PID pada SEPIC
converter
function error = calculateError(k)
    assignin('base', 'k', k);
    % Kode simulasi SEPIC converter
    sim("PlantforGAtesting.slx");
    % Fungsi Objektif
    error = ISE(length(ISE));
end

% Fungsi-fungsi bantu
function parentIndex = selectionTournament(error, m, populationSize)
    parentIndex = zeros(m, 1);
    for i = 1:m
        candidates = randperm(populationSize, 2);
        if error(candidates(1)) <= error(candidates(2))
            parentIndex(i) = candidates(1);
        else
            parentIndex(i) = candidates(2);
        end
    end
end

function offspring = crossover(parents, parentIndex, nGen)
    n = numel(parentIndex);
    offspringNum = n/2;
    crossoverPoint = randi([1, nGen-1]);
    offspring = zeros(offspringNum, nGen);
    for i = 1:offspringNum
        candidates = randperm(n, 2);
        offspring(i, :) = [parents(candidates(1), 1:crossoverPoint),
parents(candidates(2), crossoverPoint+1:end)];
    end
end

function mutatedOffspring = mutation(offspring, mutationProbability)
    mutatedOffspring = offspring;
    n = numel(mutatedOffspring);
    ranNum = 0.01*rand(n,1);
    for i = 1:n
        if ranNum < mutationProbability
            mutatedOffspring(i) = ranNum(i);
        end
    end
end

function [newPopulation, newError] = replace(population, error,
parentIndex, offspring, offspringError, populationSize)
    newPopulation = population;
```

```
    newError = error;
    m = numel(parentIndex)/2;
    sorting = sort(newError, 'descend');
    nMaxError = sorting(m);
    maxErrorIndices = zeros(m,1);
    for i = 1:populationSize
        if newError(i) >= nMaxError
            maxErrorIndices(i) = i;
        end
    end
    maxErrorIndices = maxErrorIndices(maxErrorIndices ~= 0);
    for a = 1:m
        if newError(maxErrorIndices(a)) >= offspringError(a)
            newPopulation(maxErrorIndices(a), :) = offspring(a, :);
            newError(maxErrorIndices(a)) = offspringError(a);
        end
    end
end
```

Lampiran C. Program Algoritma Metode PSO

```
clc

% Inisialisasi nilai awal
nParticles = 50;
nVariables = 2;
maxIterations = 8;
minValues = [0, 0];
maxValues = [1, 1];

% Inisialisasi posisi dan kecepatan partikel awal secara acak
positions = rand(nParticles, nVariables) .* (maxValues - minValues) +
minValues;
velocities = zeros(nParticles, nVariables) .* (maxValues - minValues) +
minValues;

% Inisialisasi posisi dan nilai pBest (nilai terbaik partikel) awal
pBestPositions = positions;
pBestValues = 100*ones(nParticles, 1);

% Inisialisasi gBest (nilai terbaik global) awal
[~, gBestIndex] = min(objectiveFunction(positions));
gBestPosition = positions(gBestIndex, :);
gBestValue = pBestValues(gBestIndex);

% Iterasi PSO
iteration = 1;
while iteration <= maxIterations

    % Update pBest
    for i = 1:nParticles
        particlePosition = positions(i, :);
        particleValue = objectiveFunction(particlePosition);

        if particleValue < pBestValues(i)
            pBestPositions(i, :) = particlePosition;
            pBestValues(i) = particleValue;
        end
    end

    % Update gBest
    [~, newGBestIndex] = min(pBestValues);
    if pBestValues(newGBestIndex) < gBestValue
        gBestPosition = pBestPositions(newGBestIndex, :);
        gBestValue = pBestValues(newGBestIndex);
    end

    % Update kecepatan dan posisi partikel (the formula based on
Clerc,1999 study)
    phi1 = 2.05;
    phi2 = 2.05;
    phi =  phi1 + phi2;
    w = 2/abs((2-phi-sqrt(phi^2-4*phi)));
```

```
    c1 = w*phi1;
    c2 = w*phi2;

    for i = 1:nParticles
        r1 = rand();
        r2 = rand();

        velocities(i, :) = w * velocities(i, :) + c1 * r1 *
abs(pBestPositions(i, :) ...
            - positions(i, :)) + c2 * r2 * abs(gBestPosition -
positions(i, :));
        positions(i, :) = positions(i, :) + velocities(i, :);
    end

    iteration = iteration + 1;
    disp('Posisi terbaik sementara:');
    disp(gBestPosition);
    disp('Minimum error sementara:');
    disp(gBestValue);
end

% Hasil akhir
disp('Parameter PI terbaik:');
disp(gBestPosition);
disp('Minimum error:');
disp(gBestValue);

% Fungsi untuk menghitung performa sistem kontrol PID pada SEPIC
converter
function error = objectiveFunction(k)
    % Kode simulasi SEPIC
    assignin('base', 'k', k);
    sim("PLANTforPSOtesting.slx");
    % Fungsi Objektif
    error = ISE(length(ISE));
end
```

Lampiran D. *Screenshot* Perancangan Metode *Fuzzy*