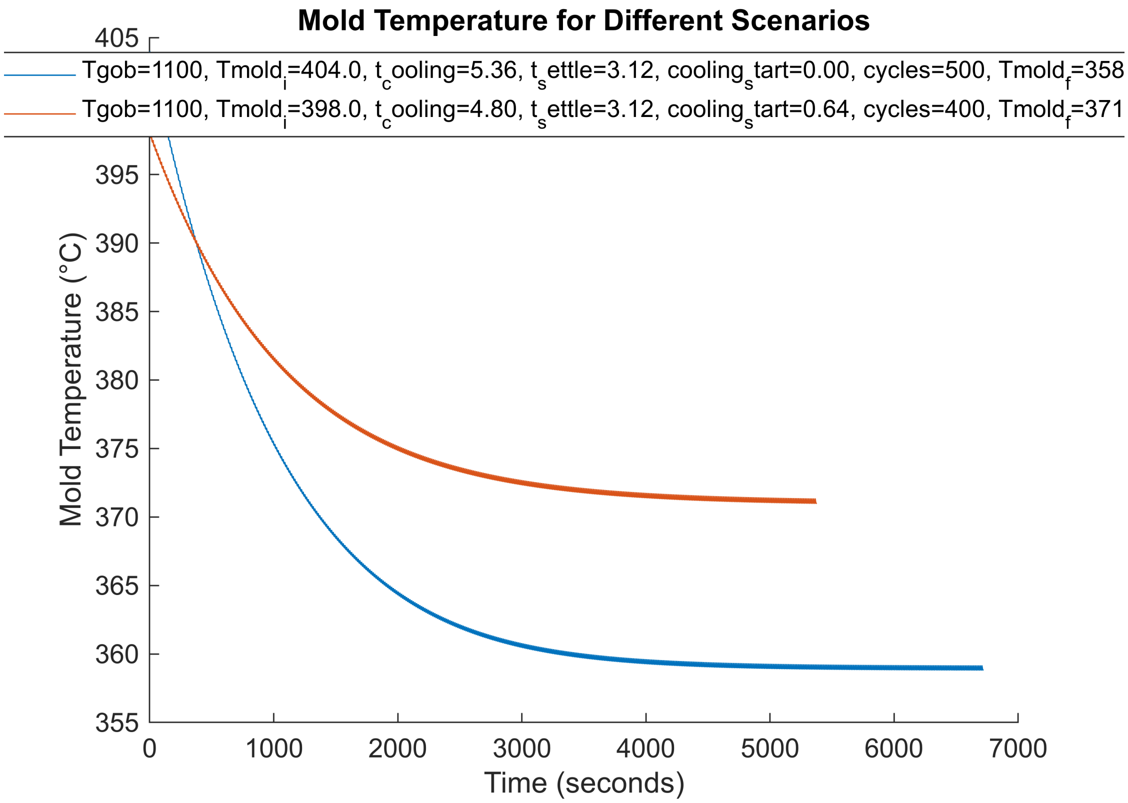
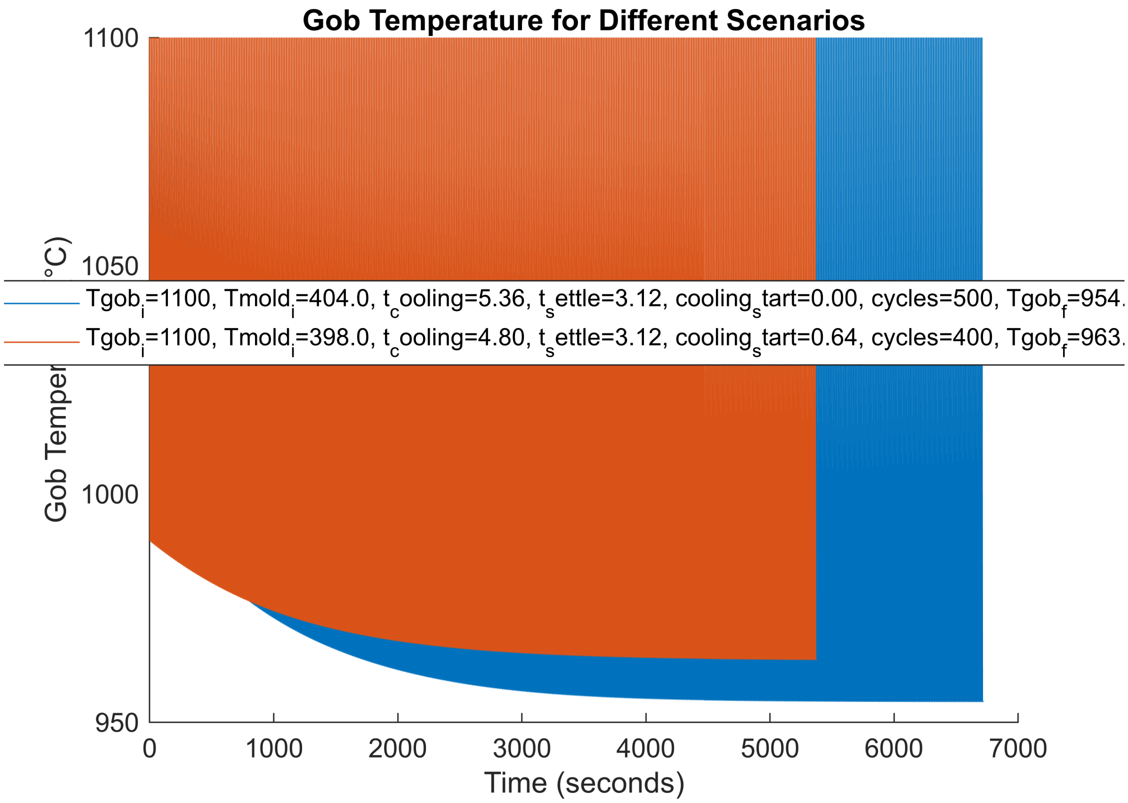
```
% Define your different scenarios by populating arrays
T_mold_initial_list = [404.001930153661, 398];  % Add more initial mold
temperatures as needed
T_gob_initial_list  = [1100, 1100];    % Add more gob temperatures as needed
t_cooling_list      = [5.36, 4.8];        % Cooling times for each scenario
t_settle_list       = [3.12, 3.12];      % Settle times for each scenario
cycles_list         = [500, 400];      % Number of simulation cycles for each
scenario
cooling_start_list  = [0, 0.64];      % When the cooling starts for each scenario

% Check that all input lists have the same length
assert(length(T_mold_initial_list) == length(T_gob_initial_list) && ...
       length(T_mold_initial_list) == length(t_cooling_list) && ...
       length(T_mold_initial_list) == length(t_settle_list) && ...
       length(T_mold_initial_list) == length(cycles_list) && ...
       length(T_mold_initial_list) == length(cooling_start_list), ...
       'All input lists must have the same number of scenarios.');

% Predefine parameters that are constant across all scenarios
t_settle_start   = 0.0;        % Settle start time in the cycle
t_cycle          = 13.36;      % Total cycle time
t_step           = 0.08;       % Step time for simulation and integration

% Prepare to plot all scenarios in one figure for mold and gob
figure_mold = figure; hold on; % Figure for mold temperature
figure_gob = figure; hold on;  % Figure for gob temperature

labels_mold = {};  % To store legend labels for mold
labels_gob = {};   % To store legend labels for gob

% Loop over each scenario
for scenario = 1:length(T_mold_initial_list)

    % Extract scenario-specific parameters
    T_mold_initial = T_mold_initial_list(scenario);
    T_gob_initial  = T_gob_initial_list(scenario);
    t_cooling      = t_cooling_list(scenario);
    t_settle       = t_settle_list(scenario);
    cooling_start  = cooling_start_list(scenario);  % Cooling start time
    cycles_to_sim  = cycles_list(scenario);

    % Ensure that the counter blow phase starts after the settle phase ends
    t_counter_start = t_settle_start + t_settle;  % Counter starts after settling
    t_counter_duration = 1.56;  % Duration of counter blow phase

    % Run the simulation for the current scenario
    gob_ts = {};
    mold_ts = {};

    % Set initial conditions
```

```
    T_mold = T_mold_initial;

    for i = 1:cycles_to_sim
        [gob_cycle, mold_cycle] = cycle_simulation(...
            T_gob_initial, T_mold, ...
            t_settle_start, t_settle, ...
            t_counter_start, t_counter_duration, ...
            cooling_start, t_cooling, ...  % Start cooling at "cooling_start" time
            t_cycle, t_step);

        gob_ts = [gob_ts, gob_cycle];
        mold_ts = [mold_ts, mold_cycle];
        T_mold = mold_ts{end};  % Update mold temperature for the next cycle
    end

    % Generate time axis for the plots
    timestamps = (0.0:t_step:(length(gob_ts)-1)*t_step);

    % Plot the results for the current scenario (Mold Temperature)
    figure(figure_mold);
    plot(timestamps, cell2mat(mold_ts));

    % Plot the results for the current scenario (Gob Temperature)
    figure(figure_gob);
    plot(timestamps, cell2mat(gob_ts));

    % Extract the final mold and gob temperature for this scenario
    final_mold_temp = mold_ts{end};
    final_gob_temp = gob_ts{end};

    % Add a label for mold temperature, including the final mold temperature
    labels_mold{end+1} = sprintf('Tgob=%d, Tmold_i=%.1f, t_cooling=%.2f,
t_settle=%.2f, cooling_start=%.2f, cycles=%d, Tmold_f=%.1f°C', ...
                            T_gob_initial, T_mold_initial, t_cooling, t_settle,
cooling_start, cycles_to_sim, final_mold_temp);

    % Add a label for gob temperature, including the final gob temperature
    labels_gob{end+1} = sprintf('Tgob_i=%d, Tmold_i=%.1f, t_cooling=%.2f,
t_settle=%.2f, cooling_start=%.2f, cycles=%d, Tgob_f=%.1f°C', ...
                            T_gob_initial, T_mold_initial, t_cooling, t_settle,
cooling_start, cycles_to_sim, final_gob_temp);
end

% Customize the plot for Mold Temperature
figure(figure_mold);
title('Mold Temperature for Different Scenarios');
xlabel('Time (seconds)');
ylabel('Mold Temperature (°C)');
legend(labels_mold, 'Location', 'Best');
hold off;
```




```
% Customize the plot for Gob Temperature
figure(figure_gob);
title('Gob Temperature for Different Scenarios');
xlabel('Time (seconds)');
ylabel('Gob Temperature (°C)');
legend(labels_gob, 'Location', 'Best');
hold off;
```




```
%% Function Definitions
```

```
function [gob_ts, mold_ts] = cycle_simulation(...
    T_gob_initial, T_mold_initial,...
    t_settle_start, t_settle_duration,...
    t_counter_start, t_counter_duration,...
    cooling_start, t_cooling_duration,...
    cycle_end, t_step)
% Simulation of one cycle to calculate gob and mold temperatures

    T_gob = T_gob_initial;
    T_mold = T_mold_initial;
    time = 0.0;
    gob_ts = {T_gob_initial};
    mold_ts = {T_mold_initial};

    [a1, a2, b1, b2, ks, kc] = load_coefficients(T_gob_initial, ...
                                             t_settle_duration, ...
                                             t_cooling_duration);

    while time < cycle_end

        is_settle = (time >= t_settle_start) & ...
```

```
                      (time <  t_settle_start + t_settle_duration);

        is_counter = (time >= t_counter_start) & ...
                     (time <  t_counter_start + t_counter_duration);

        is_cooling = (time >= cooling_start) & ...
                     (time <  cooling_start + t_cooling_duration);

        % Ensure that settle and counter phases do not overlap
        assert(~(is_settle & is_counter), 'Settle and counter phases should not
overlap.');

        % Simulate the current step for gob and mold temperature
        [T_gob, T_mold, ~, ~] = cycle_step_simulation(...
            T_gob, T_mold, is_settle, is_counter, ...
            is_cooling, t_step, ...
            a1, a2, b1, b2, ks, kc);

        gob_ts{end+1} = T_gob;
        mold_ts{end+1} = T_mold;
        time = time + t_step;
    end
end


% Cycle step simulation function
%% Add this after your main loop or other function definitions

% Cycle step simulation function
function [T_gob, T_mold, hf_gob, hf_cool] = cycle_step_simulation(...
    T_gob_initial, T_mold_initial,...
    is_settle, is_counter, is_cooling, t_step, ...
    a1, a2, b1, b2, ks, kc)
% This function simulates a step in the cycle based on the phase

    T_gob = T_gob_initial;
    T_mold = T_mold_initial;
    hf_gob = 0;
    hf_cool = 0;

    assert(~(is_settle & is_counter), 'Settling and counter phases overlap!')

    if is_settle
        [T_gob, T_mold, hf_gob] = ...
           simulate_settle(a1, a2, ks, T_gob, T_mold, t_step);
    end

    if is_counter
       [T_gob, T_mold, hf_gob] = ...
           simulate_counter(b1, b2, kc, T_gob, T_mold, t_step);
```

```
    end

    if is_cooling
       [T_mold, hf_cool] = simulate_cooling(T_mold, t_step);
    end

    if ~is_settle && ~is_counter && ~is_cooling
       T_mold = simulate_passive_cooling(T_mold, t_step);
    end
end

% Apply coefficients for polynomial fit
function y = apply_cffs(c, x)
    y = c(1) + c(2) * x + c(3) * x^2 + c(4) * x^3;
end

% Settling phase simulation
function [T_g_s, T_m_s, hf_settle] = ...
    simulate_settle(a1, a2, ks, T_g, T_m, t_step)

    T_g_surface = apply_cffs(a2, T_g - T_m);
    T_m_surface = apply_cffs(a1, T_g - T_m);

    % Physical properties of the mold
    c_mold = 2278.4;       % J/(kg-K)
    d_mold = 7300.0 ;      % kg/m^3
    v_mold = 2.196412e-03; % m^3
    C_mold = 1 / (c_mold * d_mold * v_mold);

    % Physical properties of the gob
    c_gob = 1460.0;       % @1100 *C J/(kg-K)
    d_gob = 2350.0;       % kg/m^3
    v_gob = 9.288814e-05; % m^3
    C_gob = 1 / (c_gob * d_gob * v_gob);

    S_settle = 1.011951e-02;  % Surface area of mold-gob interface in settling phase
    hf_settle = S_settle * apply_cffs(ks, T_g_surface - T_m_surface);

    T_m_s = T_m - (hf_settle * C_mold * t_step);
    T_g_s = T_g + (hf_settle * C_gob  * t_step);
end

% Counter blow phase simulation
function [T_g_c, T_m_c, hf_counter] = ...
    simulate_counter(b1, b2, kc, T_g, T_m, t_step)

    % Physical properties of the mold
    c_mold = 2278.4;       % J/(kg-K)
    d_mold = 7300.0 ;      % kg/m^3
    v_mold = 2.196412e-03; % m^3
```

```
    C_mold = 1 / (c_mold * d_mold * v_mold);

    % Physical properties of the gob
    c_gob = 1460.0;        % @1100 *C J/(kg-K)
    d_gob = 2350.0;        % kg/m^3
    v_gob = 9.288814e-05; % m^3
    C_gob = 1 / (c_gob * d_gob * v_gob);

    S_counter = 1.504496e-02; % Surface area of gob-mold interface in counter blow
phase
    T_g_surface = apply_cffs(b2, T_g - T_m);
    T_m_surface = apply_cffs(b1, T_g - T_m);

    hf_counter = S_counter * apply_cffs(kc, T_g_surface - T_m_surface);

    T_m_c = T_m - (hf_counter * C_mold * t_step);
    T_g_c = T_g + (hf_counter * C_gob  * t_step);

end

% Cooling phase simulation
function [T_m_c, hf_cooling] = simulate_cooling(T_m, t_step)

    % Physical properties of the mold
    c_mold = 2278.4;        % J/(kg-K)
    d_mold = 7300.0 ;       % kg/m^3
    v_mold = 2.196412e-03; % m^3
    C_mold = 1 / (c_mold * d_mold * v_mold);

    T_air = 70; % Ambient air temperature
    S_aria = 7.932558e-02; % Surface area exposed to air for cooling
    hf_cooling = S_aria * 360 * (T_air - T_m); % Heat flux for cooling

    T_m_c = T_m + (hf_cooling * C_mold * t_step);
end

% Passive cooling simulation
function T_m_c = simulate_passive_cooling(T_m, t_step)

    % Physical properties of the mold
    c_mold = 2278.4;        % J/(kg-K)
    d_mold = 7300.0 ;       % kg/m^3
    v_mold = 2.196412e-03; % m^3
    C_mold = 1 / (c_mold * d_mold * v_mold);

    T_air = 70; % Ambient air temperature

    % Get passive cooling using regression (assuming experiments were at T_air =
50°C)
    hf_passive = (T_m - T_air) * 1.053 - 40.99;
```

```
    T_m_c = T_m - (hf_passive * C_mold * t_step);
end


% Coefficient loading function
function [a1, a2, b1, b2, ks, kc] = load_coefficients(...
    T_gob, t_settle, t_counter)
% Function to load or interpolate coefficients

    % This assumes coefficients are already loaded into the workspace,
    % using the interpolation logic defined in the earlier code.

    interpolation
    a1 = [ alfa1_i{1}(T_gob, t_settle, t_counter), ...
           alfa1_i{2}(T_gob, t_settle, t_counter), ...
           alfa1_i{3}(T_gob, t_settle, t_counter), ...
           alfa1_i{4}(T_gob, t_settle, t_counter) ];

    a2 = [ alfa2_i{1}(T_gob, t_settle, t_counter), ...
           alfa2_i{2}(T_gob, t_settle, t_counter), ...
           alfa2_i{3}(T_gob, t_settle, t_counter), ...
           alfa2_i{4}(T_gob, t_settle, t_counter) ];

    b1 = [ beta1_i{1}(T_gob, t_settle, t_counter), ...
           beta1_i{2}(T_gob, t_settle, t_counter), ...
           beta1_i{3}(T_gob, t_settle, t_counter), ...
           beta1_i{4}(T_gob, t_settle, t_counter) ];

    b2 = [ beta2_i{1}(T_gob, t_settle, t_counter), ...
           beta2_i{2}(T_gob, t_settle, t_counter), ...
           beta2_i{3}(T_gob, t_settle, t_counter), ...
           beta2_i{4}(T_gob, t_settle, t_counter) ];

    ks = [ k_settle_i{1}(T_gob, t_settle, t_counter), ...
           k_settle_i{2}(T_gob, t_settle, t_counter), ...
           k_settle_i{3}(T_gob, t_settle, t_counter), ...
           k_settle_i{4}(T_gob, t_settle, t_counter) ];

    kc = [ k_counter_i{1}(T_gob, t_settle, t_counter), ...
           k_counter_i{2}(T_gob, t_settle, t_counter), ...
           k_counter_i{3}(T_gob, t_settle, t_counter), ...
           k_counter_i{4}(T_gob, t_settle, t_counter) ];
end

% Interpolation function (previously defined)
function tl = get_param_tl(param)
    TEMPERATURES  = [ 1100.0, 1150.0, 1200.0 ];
    SETTLE_TIMES  = [ 1.52, 1.92, 2.32, 2.72, 3.12 ];
    COOLING_TIMES = [ 3.60, 4.00, 4.48, 4.88, 5.36  ];
```

```
    tmp = zeros(length(TEMPERATURES), ...
                length(SETTLE_TIMES), ...
                length(COOLING_TIMES));
    for i = 1:length(TEMPERATURES)
        for j = 1:length(SETTLE_TIMES)
            for k = 1:length(COOLING_TIMES)
                idx = (i - 1) * 25 + (5 - (j - 1) - 1) * 5 + 5 - (k - 1);
                tmp(i, j, k) = param(idx);
            end
        end
    end
    tl = griddedInterpolant({ TEMPERATURES, SETTLE_TIMES, COOLING_TIMES }, ...
                            tmp, 'linear');
end
```