Rotating magnetic field(6) :

```
% M-file: mag_field.m
% Simulating the Rotating Magnetic Field in a 3-phase Stator

% Step 1: Set up basic conditions
bmax = 1;             % Normalized maximum magnetic field strength
freq = 60;            % Frequency in Hz
w = 2 * pi * freq;    % Angular velocity (rad/s)

% Step 2: Generate time vector for smooth animation
t = 0:1/6000:1/60;    % Time vector for one cycle (fine resolution)

% Step 3: Generate the three magnetic field components
Baa = sin(w * t) .* (cos(0) + 1i * sin(0));          % Phase A
Bbb = sin(w * t - 2*pi/3) .* (cos(2*pi/3) + 1i * sin(2*pi/3));  % Phase B
Bcc = sin(w * t + 2*pi/3) .* (cos(-2*pi/3) + 1i * sin(-2*pi/3)); % Phase C

% Step 4: Calculate the net magnetic field
Bnet = Baa + Bbb + Bcc;

% Step 5: Generate reference circle for visualization
circle = bmax * (cos(w * t) + 1i * sin(w * t));

% Step 6: Plotting the results
figure; % Create a figure window
for il = 1:length(t)
    clf;  % Clear the figure for the next frame

    % Plot the reference circle
    plot(real(circle), imag(circle), 'k--');
    hold on;

    % Plot the individual magnetic fields
    plot([0 real(Baa(il))], [0 imag(Baa(il))], 'k', 'LineWidth', 2); %
Phase A (Black)
    plot([0 real(Bbb(il))], [0 imag(Bbb(il))], 'b', 'LineWidth', 2); %
Phase B (Blue)
    plot([0 real(Bcc(il))], [0 imag(Bcc(il))], 'm', 'LineWidth', 2); %
Phase C (Magenta)

    % Plot the net magnetic field (Resultant)
    plot([0 real(Bnet(il))], [0 imag(Bnet(il))], 'r', 'LineWidth', 3); %
Resultant (Red)

    % Axis settings
    axis square;
```

```
    axis([-1.5 1.5 -1.5 1.5]); % Adjusted for better visualization

    drawnow;
    hold off;
end
```

---

7. Synchronous Generator:

```
% M-file: term_char_all.m
% M-file to plot the terminal characteristics of the generator
% for various power factors (both leading and lagging)

% Initialize the current amplitudes (21 values in the range 0-60 A)
i_a = (0:1:20) * 3;

% Initialize other parameters
e_a = 277.0;  % Internal generated voltage
x_s = 1.0;    % Synchronous reactance

% Define power factor angles (in radians) for lagging and leading cases
pf_values = [0.2, 0.4, 0.6, 0.8];
theta_lagging = acos(pf_values);   % Lagging power factor (current lags voltage)
theta_leading = acos(-pf_values);  % Corrected Leading power factor calculation

% Colors for different plots
colors = ['r', 'g', 'b', 'm'];

figure;
hold on;

% Plot terminal characteristics for lagging power factors
for idx = 1:length(pf_values)
   v_phase = zeros(1, 21);
   theta = theta_lagging(idx);

   for ii = 1:21
      v_phase(ii) = sqrt(e_a^2 - (x_s * i_a(ii) * sin(theta))^2) ...
               - (x_s * i_a(ii) * cos(theta));
   end

   v_t = v_phase * sqrt(3);
```

```
    plot(i_a, v_t, 'Color', colors(idx), 'Linewidth', 2.0, 'DisplayName', ...
        sprintf('Lagging PF = %.1f', pf_values(idx)));
end

% Plot terminal characteristics for leading power factors
for idx = 1:length(pf_values)
    v_phase = zeros(1, 21);
    theta = theta_leading(idx);

    for ii = 1:21
        v_phase(ii) = sqrt(e_a^2 - (x_s * i_a(ii) * sin(theta))^2) ...
                    - (x_s * i_a(ii) * cos(theta));
    end

    v_t = v_phase * sqrt(3);
    plot(i_a, v_t, '--', 'Color', colors(idx), 'Linewidth', 2.0, 'DisplayName', ...
        sprintf('Leading PF = %.1f', pf_values(idx)));
end

% Add labels, title, and legend
xlabel('Line Current (A)', 'Fontweight', 'Bold');
ylabel('Terminal Voltage (V)', 'Fontweight', 'Bold');
title('Terminal Characteristics for Various Power Factors', 'Fontweight', 'Bold');
grid on;
axis([0 60 400 550]);
legend show;
hold off;
```

---

8. Torque vs Speed of induction

```
% Torque-Speed Characteristics of Induction Motor with varying Rr'
clear; clc;

% Constants
V = 220;          % Phase voltage (V)
f = 50;           % Frequency (Hz)
p = 4;            % Poles
Ns_rpm = 120*f/p;    % Synchronous speed in RPM
ws = 2*pi*Ns_rpm/60; % Synchronous speed in rad/s

% Motor parameters
Xs = 1.5;         % Stator reactance (Ohm)
```

```
Xr = 1.5;           % Rotor reactance (Ohm)
Xm = Xs + Xr;       % Total reactance

% Rotor resistances to simulate
Rr_values = [0.5, 1, 2];  % Ohms

% Slip range (avoid division by zero at s=0)
s = linspace(0.001, 1, 1000);

% Plotting
figure;
hold on;
for Rr = Rr_values
    T = (3*V^2*Rr./s) ./ (ws*((Rr./s).^2 + Xm^2));
    plot((1 - s)*Ns_rpm, T, 'LineWidth', 1, 'DisplayName', ['Rr = ' num2str(Rr) ' \Omega']);
end

title('Torque-Speed Characteristics of Induction Motor');
xlabel('Rotor Speed (RPM)');
ylabel('Torque (Nm)');
legend('Location','northeast');
grid on;
```