# Evaluación: Localización de un robot diferencial

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# Inicialización

Se inicia limpiando la consola y la memoria para evitar conflictos de datos anteriores.

```
clear all
close all
clc
```

# **Ejercicio 1**

# Tiempo

Se definen los parámetros temporales del experimento: tiempo de intregración por paso (ts), y el numero de pasos (N)

```
ts = 1;
N = 12;
```

## Pose inicial

Se define la coordenada y orientación inicial del robot

```
x = -1;
y = -5;
theta = deg2rad(0);
```

#### **Pasos**

Se establece el historial de pasos descrito en el ejercicio

```
pasos = [
   1.0,
          0.0;
   0.0, pi/3;
   1.0,
        0.0;
   0.0, pi/3;
   1.0,
        0.0;
   0.0, pi/3;
   1.0, 0.0;
   0.0, pi/3;
   1.0,
        0.0;
   0.0, pi/3;
   1.0, 0.0;
   0.0, pi/3
];
```

# Bucle de simulación

El bucle for que recorre todas las muestras temporales. Se establecen las velocidad don la matriz de pasos.

```
for k = 1:N
  v = pasos(k, 1);  % velocidad lineal
  w = pasos(k, 2);  % velocidad angular
```

En cada iteración, se actualizan las cordenadas (x,y) y la orientación theta del robot utilizando integración numérica con el método de Euler.

```
x = x + v * cos(theta) * ts;
y = y + v * sin(theta) * ts;
theta = theta + w * ts;
```

#### **Poses**

Finalmente, imprimimos las poses del robot en cada paso

```
fprintf('Paso %2d: x = \%.3f, y = \%.3f, \theta = \%.2f^{\circ} n', k, x, y, rad2deg(theta));
end
Paso 1: x = 0.000, y = -5.000, \theta = 0.00^{\circ}
Paso 2: x = 0.000, y = -5.000, \theta = 60.00^{\circ}
Paso 3: x = 0.500, y = -4.134, \theta = 60.00^{\circ}
Paso 4: x = 0.500, y = -4.134, \theta = 120.00^{\circ}
Paso 5: x = 0.000, y = -3.268, \theta = 120.00^{\circ}
Paso 6: x = 0.000, y = -3.268, \theta = 180.00^{\circ}
Paso 7: x = -1.000, y = -3.268, \theta = 180.00^{\circ}
Paso 8: x = -1.000, y = -3.268, \theta = 240.00^{\circ}
Paso 9: x = -1.500, y = -4.134, \theta = 240.00^{\circ}
Paso 10: x = -1.500, y = -4.134, \theta = 300.00^{\circ}
Paso 11: x = -1.000, y = -5.000, \theta = 300.00^{\circ}
Paso 12: x = -1.000, y = -5.000, \theta = 360.00^{\circ}
% Pose final
fprintf('\nPose final del robot:\n'); fprintf('x = %.3f, y = %.3f, \theta = %.2f°\n', x,
y, rad2deg(theta));
Pose final del robot:
x = -1.000, y = -5.000, \theta = 360.00^{\circ}
```

# Ejercicio 2

#### Parámetros del robot

Se definen las dimensiones físicas del robot, necesarias para calcular las velocidades lineales y angulares a partir de las velocidades de las ruedas.

```
r = 0.1; % Radio de rueda
L = 0.4; % Distancia entre ruedas
```

# Velocidades angulares de las ruedas

Se asignan las velocidades angulares (rad/s) de cada rueda para la simulación. Estas determinan cómo se mueve el robot en cada instante de tiempo.

```
wR = [4.582; 4.773; 5.291; 5.960; 6.490; -1.168; -1.364; 5.960; 5.291; 4.773; 4.582; 4.773; 5.291; 5.960; 6.490; 6.686; 6.490; 5.960; 5.291; 4.773; 4.582];
```

```
wL = [1.701; 2.353; 3.676; 4.856; 5.618; 13.735; 13.472; 4.856; 3.676; 2.353; 1.701; 2.353; 3.676; 4.856; 5.618; 5.881; 5.618; 4.856; 3.676; 2.353; 1.701];
```

## Cálculo de velocidades de referencia

A partir de las velocidades angulares de cada rueda, se obtienen las velocidades lineales u0 y angulares w0 del robot, usando el modelo cinemático de un robot diferencial.

```
u0 = (r/2) .* (wR + wL);

w0 = (r/L) .* (wR - wL);
```

# **Tiempo**

Se define el nuevo tiempo de muestreo y se interpola para obtener un mayor detalle temporal en la simulación. Esto permite visualizar el comportamiento del robot con más precisión.

```
ts = 1;
t_original = 0:1:(length(u0)-1);
t = 0:ts:t_original(end);

% Interpolación para aumentar la resolución temporal
u = interp1(t_original, u0, t, 'linear');
w = interp1(t_original, w0, t, 'linear');
N = length(u);
```

# Condiciones iniciales

Se inicializa la posición y orientación del robot en el origen. También se inicializan los vectores para almacenar la evolución de estas variables.

```
x1 = zeros(1,N+1);
y1 = zeros(1,N+1);
phi = zeros(1,N+1);

x1(1) = 0;
y1(1) = 0;
phi(1) = 0;
```

## Punto de control

Se definen vectores para registrar la trayectoria del punto de control del robot (el centro del eje entre ruedas).

```
hx = zeros(1,N+1);
hy = zeros(1,N+1);

hx(1) = x1(1);
hy(1) = y1(1);
```

## Bucle de simulación

En cada paso de tiempo se actualiza la orientación y posición del robot usando el método de integración de Euler, a partir de las velocidades interpoladas.

```
for k=1:N
    phi(k+1)=phi(k)+w(k)*ts;
    xp1=u(k)*cos(phi(k+1));
    yp1=u(k)*sin(phi(k+1));
    x1(k+1)=x1(k) + xp1*ts;
    y1(k+1)=y1(k) + yp1*ts;
    hx(k+1)=x1(k+1);
    hy(k+1)=y1(k+1);
end
```

# Resultados

Se imprime el resultado de cada paso de tiempo, incluyendo velocidades y posición/orientación del robot.

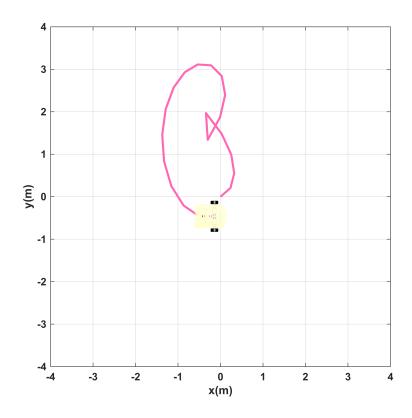
```
for k = 1:N
     fprintf('t(s) = %-10.3f | v(m/s) = %-10.3f | w(rad/s) = %-10.3f | x(m) =
%-10.3f | y(m) = %-10.3f phi(°) = %-10.3f h', t(k), u(k), w(k), x1(k), y1(k),
rad2deg(phi(k)));
end
t(s) = 0.000
                    v(m/s) = 0.314
                                           w(rad/s) = 0.720
                                                                    x(m) = 0.000
                                                                                         y(m) = 0.000
                                                                                                            phi(\circ) = 0.0
t(s) = 1.000
                    v(m/s) = 0.356
                                           w(rad/s) = 0.605
                                                                    x(m) = 0.236
                                                                                         y(m) = 0.207
                                                                                                            phi(^{\circ}) = 41
                                                                                         y(m) = 0.553
t(s) = 2.000
                    v(m/s) = 0.448
                                           w(rad/s) = 0.404
                                                                    x(m) = 0.323
                                                                                                            phi(^{\circ}) = 75
                                                                                         y(m) = 0.996
                                                                                                            phi(^{\circ}) = 99
t(s) = 3.000
                    v(m/s) = 0.541
                                           w(rad/s) = 0.276
                                                                    x(m) = 0.252
                                                                                                            phi(\circ) = 114
t(s) = 4.000
                    v(m/s) = 0.605
                                           w(rad/s) = 0.218
                                                                    x(m) = 0.025
                                                                                         y(m) = 1.486
                                                                                         y(m) = 1.967
                                                                                                            phi(°) = 12°
t(s) = 5.000
                    v(m/s) = 0.628
                                           w(rad/s) = -3.726
                                                                    x(m) = -0.343
                                                                    x(m) = -0.300
                                                                                                            phi(\circ) = -80
t(s) = 6.000
                    v(m/s) = 0.605
                                           w(rad/s) = -3.709
                                                                                       y(m) = 1.340
                                                                                                            phi(\circ) = -2
t(s) = 7.000
                    v(m/s) = 0.541
                                           w(rad/s) = 0.276
                                                                  x(m) = -0.010
                                                                                       y(m) = 1.872
                                                                                                            phi(\circ) = -2i
t(s) = 8.000
                    v(m/s) = 0.448
                                           w(rad/s) = 0.404
                                                                  | x(m) = 0.110
                                                                                       | y(m) = 2.399
t(s) = 9.000
                    v(m/s) = 0.356
                                          | w(rad/s) = 0.605
                                                                  x(m) = 0.029
                                                                                       | y(m) = 2.840
                                                                                                            phi(\circ) = -2
t(s) = 10.000
                                          | w(rad/s) = 0.720
                                                                                       | y(m) = 3.092
                                                                                                            phi(\circ) = -2
                    v(m/s) = 0.314
                                                                  | x(m) = -0.223
t(s) = 11.000
                                                                                                            phi(\circ) = -13
                    v(m/s) = 0.356
                                           w(rad/s) = 0.605
                                                                  | x(m) = -0.536
                                                                                       | y(m) = 3.113
                                                                  | x(m) = -0.842
                                                                                                            phi(\circ) = -14
t(s) = 12.000
                    v(m/s) = 0.448
                                           w(rad/s) = 0.404
                                                                                       | y(m) = 2.930
                                                                                                            phi(\circ) = -1
t(s) = 13.000
                                           w(rad/s) = 0.276
                                                                  | x(m) = -1.105
                                                                                       | y(m) = 2.567
                    v(m/s) = 0.541
                                                                                                            phi(\circ) = -1
t(s) = 14.000
                    v(m/s) = 0.605
                                           w(rad/s) = 0.218
                                                                  | x(m) = -1.291
                                                                                       | y(m) = 2.059
                                                                                                            phi(^{\circ}) = -9
                                                                                       | y(m) = 1.459
t(s) = 15.000
                    v(m/s) = 0.628
                                           w(rad/s) = 0.201
                                                                    x(m) = -1.372
                                                                                                            phi(\circ) = -8e
                                                                                         y(m) = 0.832
t(s) = 16.000
                    v(m/s) = 0.605
                                           w(rad/s) = 0.218
                                                                    x(m) = -1.329
                                                                                                            phi(\circ) = -7
t(s) = 17.000
                    v(m/s) = 0.541
                                           w(rad/s) = 0.276
                                                                    x(m) = -1.158
                                                                                       y(m) = 0.251
                                                                                                            phi(^{\circ}) = -5^{\circ}
t(s) = 18.000
                    v(m/s) = 0.448
                                           w(rad/s) = 0.404
                                                                    x(m) = -0.870
                                                                                         y(m) = -0.207
t(s) = 19.000
                    v(m/s) = 0.356
                                           w(rad/s) = 0.605
                                                                  | x(m) = -0.501
                                                                                       | y(m) = -0.462
                                                                                                            phi(\circ) = -34
t(s) = 20.000
                   | v(m/s) = 0.314
                                          | w(rad/s) = 0.720
                                                                  | x(m) = -0.145
                                                                                       y(m) = -0.462
                                                                                                            phi(^{\circ}) = -0
```

## Simulación 3D

Se configura una escena en 3D donde se observa el movimiento del robot en el plano XY. Se utiliza una figura gráfica que se actualiza en cada iteración del bucle para animar la trayectoria del robot.

```
scene=figure;
set(scene,'Color','white');
set(gca,'FontWeight','bold');
sizeScreen=get(0,'ScreenSize');
set(scene,'position',sizeScreen);
camlight('headlight');
```

```
axis equal;
grid on;
box on;
xlabel('x(m)'); ylabel('y(m)'); zlabel('z(m)');
view([0 90]);
axis([-4 4 -4 4 0 2]);
scale = 4;
MobileRobot_5;
H1=MobilePlot_4(x1(1),y1(1),phi(1),scale);hold on;
H2=plot3(hx(1),hy(1),0,'r','lineWidth',2);
step=1;
for k=1:step:N
    delete(H1);
    delete(H2);
    H1=MobilePlot_4(x1(k),y1(k),phi(k),scale);
   H2=plot3(hx(1:k),hy(1:k),zeros(1,k),'Color', [1 0.4 0.7],'lineWidth',2);
    pause(ts);
end
```

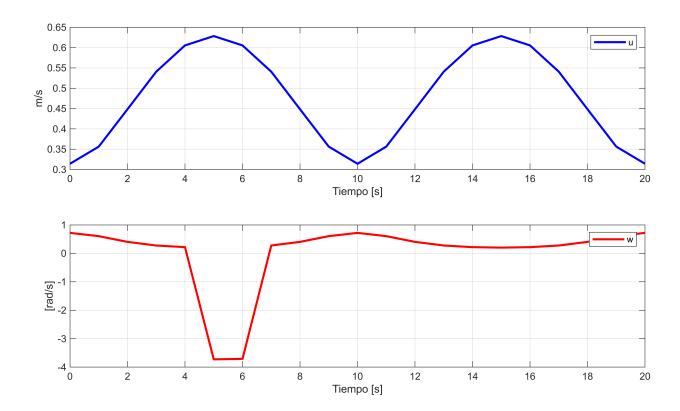


# **Gráficas**

Se visualizan las velocidades de referencia del robot (lineal y angular) y su evolución temporal en posición (x, y) y orientación (phi).

```
graph=figure;
set(graph,'position',sizeScreen);

subplot(211)
plot(t,u,'b','LineWidth',2),grid('on'),xlabel('Tiempo [s]'),ylabel('m/
s'),legend('u');
subplot(212)
plot(t,w,'r','LineWidth',2),grid('on'),xlabel('Tiempo [s]'),ylabel('[rad/
s]'),legend('w');
```



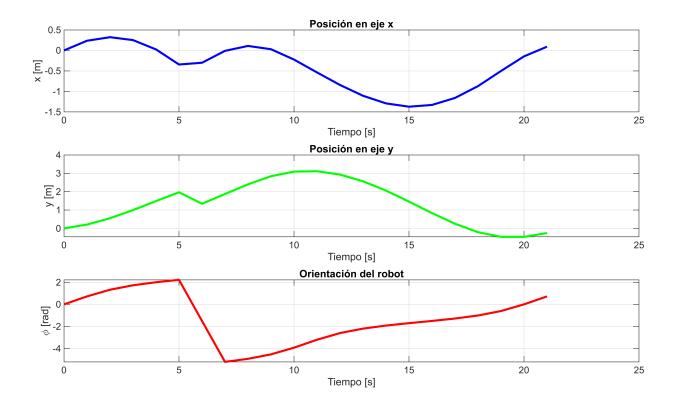
```
figure;
set(gcf,'position',sizeScreen);

subplot(3,1,1)
plot((0:N)*ts, x1, 'b', 'LineWidth', 2);
xlabel('Tiempo [s]'); ylabel('x [m]');
title('Posición en eje x');
grid on;

subplot(3,1,2)
plot((0:N)*ts, y1, 'g', 'LineWidth', 2);
xlabel('Tiempo [s]'); ylabel('y [m]');
title('Posición en eje y');
grid on;

subplot(3,1,3)
```

```
plot((0:N)*ts, phi, 'r', 'LineWidth', 2);
xlabel('Tiempo [s]'); ylabel('\phi [rad]');
title('Orientación del robot');
grid on;
```



# Ejercicio 3

# Velocidades de referencia

En esta simulación, el robot se mueve con una velocidad lineal constante de 4 m/s mientras gira continuamente con una velocidad angular constante de 1 rad/s. Este tipo de movimiento genera una trayectoria circular, lo que permite observar el comportamiento del robot al combinar traslación uniforme con una rotación sostenida.

```
u = 20*ones(1, 640);
w = 1*ones(1, 640);
```

# Tiempo

A continuación, se establecen los parámetros temporales. El número de muestras N se obtiene a partir de la longitud del vector u, mientras que el tiempo de muestreo se define como ts = 0.01 segundos. El vector de tiempo t se genera con una distribución lineal.

```
N = length(u);
tf = N*2;
ts = 0.01;
t = linspace(0, ts, N);
```

## Condiciones iniciales

Las condiciones iniciales del robot se fijan en el origen del plano, con orientación cero. Los vectores x1, y1 y phi representan respectivamente la posición en el eje X, el eje Y y la orientación del robot a lo largo de toda la simulación.

```
x1 = zeros (1,N+1);
y1 = zeros (1,N+1);
phi = zeros(1, N+1);
```

Asignamos los valores iniciales, correspondientes a la coordenada de inicio, explícitamente en la primera posición de cada vector.

```
x1(1) = 0;
y1(1) = -20;
phi(1) = 0;
```

# Punto de control

También se inicializan los vectores hx y hy que almacenarán la trayectoria del punto de control del robot (que coincide con el centro del eje entre ruedas), comenzando en la misma posición inicial del robot.

```
hx = zeros(1, N+1);
hy = zeros(1, N+1);

hx(1) = x1(1);
hy(1) = y1(1);
```

#### Bucle de simulación

El bucle for que recorre todas las muestras temporales. En cada iteración, se actualiza la orientación phi del robot utilizando integración numérica con el método de Euler. Luego, se calculan las componentes de la velocidad en los ejes X y Y considerando la orientación recién calculada. Con esas velocidades, también mediante Euler, se actualiza la posición del robot. Finalmente, se actualiza la trayectoria del punto de control con las nuevas coordenadas del centro del robot.

```
\begin{array}{l} hx(k+1) = x1(k+1); \\ hy(k+1) = y1(k+1); \\ wr_k = (2*u(k) + w(k)*L) / (2*r); \\ wl_k = (2*u(k) - w(k)*L) / (2*r); \\ fprintf('t = \%.2f \ s \ | \ \omega_R = \%.2f \ rad/s \ | \ \omega_L = \%.2f \ rad/s \ | \ k*ts, \ wr_k, \ wl_k); \\ \end{array} end
```

```
t = 0.01 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.02 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.03 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.04 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.05 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.06 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.07 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.08 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.09 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.10 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.11 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.12 s \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.13 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.14 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.15 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.16 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.17 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.18 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.19 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.20 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.21 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.22 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.23 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.24 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.25 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.26 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.27 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.28 s
                     \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.29 s
                     \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.30 s
                     \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.31 s
                     \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.32 s
                     \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.33 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.34 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.35 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.36 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.37 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.38 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.39 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.40 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.41 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.42 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.43 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.44 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.45 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.46 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.47 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.48 s
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 0.49 s
                  \omega_R = 202.00 \text{ rad/s} \quad \omega_L = 198.00 \text{ rad/s}
t = 0.50 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.51 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.52 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.53 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
```

```
t = 0.54 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.55 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 0.56 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.57 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 0.58 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 0.59 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 0.60 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.61 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.62 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.63 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.64 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.65 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.66 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.67 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.68 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.69 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.70 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.71 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.72 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.73 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 0.74 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 0.75 s
                 \omega_R = 202.00 \text{ rad/s} \quad \omega_L = 198.00 \text{ rad/s}
t = 0.76 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 0.77 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.78 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.79 s
t = 0.80 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.81 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.82 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.83 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.84 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.85 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.86 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.87 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.88 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 0.89 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.90 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.91 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.92 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 0.93 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.94 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.95 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.96 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.97 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 0.98 s
                 \omega_R = 202.00 \text{ rad/s}
                                                   \omega_L = 198.00 \text{ rad/s}
                 \omega_R = 202.00 \text{ rad/s}
                                                   | \omega_L = 198.00 \text{ rad/s}
t = 0.99 s
t = 1.00 s
                 \omega_R = 202.00 \text{ rad/s}
                                                   \omega_L = 198.00 \text{ rad/s}
t = 1.01 s
                 \omega_R = 202.00 \text{ rad/s}
                                                   \omega_L = 198.00 \text{ rad/s}
t = 1.02 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.03 s
                    \omega R = 202.00 rad/s
                                                   | \omega L = 198.00 \text{ rad/s}
t = 1.04 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 1.05 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.06 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.07 s | \omega_R = 202.00 rad/s | \omega_L = 198.00 rad/s
t = 1.08 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.09 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.10 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.11 s
t = 1.12 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 1.13 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.14 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.15 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 1.16 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.17 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
```

```
t = 1.18 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.19 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.20 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.21 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 1.22 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 1.23 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.24 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.25 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.26 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.27 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.28 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.29 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.30 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.31 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 1.32 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.33 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 1.34 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.35 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.36 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.37 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.38 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 1.39 s
                 \omega_R = 202.00 \text{ rad/s} \quad \omega_L = 198.00 \text{ rad/s}
t = 1.40 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 1.41 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 1.42 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.43 s
t = 1.44 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 1.45 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 1.46 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 1.47 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 1.48 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.49 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 1.50 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.51 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.52 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.53 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.54 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.55 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.56 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.57 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.58 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.59 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.60 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.61 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.62 s
                 \omega_R = 202.00 \text{ rad/s}
                                                  \omega_L = 198.00 \text{ rad/s}
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 1.63 s
t = 1.64 s
                 \omega_R = 202.00 \text{ rad/s}
                                                  \omega_L = 198.00 \text{ rad/s}
t = 1.65 s
                 \omega_R = 202.00 \text{ rad/s}
                                                   \omega_L = 198.00 \text{ rad/s}
t = 1.66 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.67 s
                   \omega R = 202.00 rad/s
                                                   | \omega L = 198.00 \text{ rad/s}
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.68 s
t = 1.69 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 1.70 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.71 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.72 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.73 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 1.74 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 1.75 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.76 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 1.77 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.78 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.79 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.80 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.81 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
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t = 1.82 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.83 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.84 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.85 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.86 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 1.87 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.88 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.89 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.90 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.91 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.92 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.93 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.94 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.95 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.96 s
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 1.97 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 1.98 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 1.99 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.00 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.01 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.02 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.03 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.04 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 2.05 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 2.06 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.07 s
t = 2.08 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.09 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.10 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.11 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.12 s
                     \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.13 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.14 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.15 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.16 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.17 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.18 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.19 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.20 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.21 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.22 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.23 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.24 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.25 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.26 s
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 2.27 s
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 2.28 s
                  \omega_R = 202.00 \text{ rad/s}
                                                     \omega_L = 198.00 \text{ rad/s}
t = 2.29 s
                  \omega_R = 202.00 \text{ rad/s}
                                                     \omega_L = 198.00 \text{ rad/s}
t = 2.30 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 2.31 s
                    \omega R = 202.00 rad/s
                                                     | \omega L = 198.00 \text{ rad/s}
t = 2.32 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.33 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.34 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.35 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 2.36 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.37 s
                 |\omega_R| = 202.00 \text{ rad/s} |\omega_L| = 198.00 \text{ rad/s}
t = 2.38 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 2.39 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 2.40 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.41 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 2.42 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.43 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.44 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.45 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
```

```
t = 2.46 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.47 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.48 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.49 s
                  \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 2.50 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.51 s
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 2.52 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.53 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.54 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 2.55 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.56 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 2.57 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.58 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.59 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.60 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.61 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.62 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.63 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.64 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.65 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 2.66 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.67 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.68 s
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 2.69 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.70 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.71 s
t = 2.72 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.73 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.74 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.75 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.76 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.77 s
t = 2.78 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.79 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.80 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 2.81 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.82 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.83 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.84 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 2.85 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.86 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.87 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.88 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.89 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.90 s
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 2.91 s
t = 2.92 s
                  \omega_R = 202.00 \text{ rad/s} \quad \omega_L = 198.00 \text{ rad/s}
t = 2.93 s
                  \omega_R = 202.00 \text{ rad/s}
                                                   \omega_L = 198.00 \text{ rad/s}
t = 2.94 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 2.95 s
                   \omega R = 202.00 rad/s
                                                   | \omega L = 198.00 \text{ rad/s}
t = 2.96 s
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 2.97 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.98 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 2.99 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.00 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.01 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 3.02 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 3.03 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 3.04 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.05 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 3.06 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.07 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.08 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.09 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
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```
t = 3.10 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.11 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.12 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.13 s
                  \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 3.14 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 3.15 s
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 3.16 s
t = 3.17 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.18 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.19 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.20 s
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 3.21 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 3.22 s
                 |\omega_R| = 202.00 \text{ rad/s} |\omega_L| = 198.00 \text{ rad/s}
t = 3.23 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.24 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.25 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.26 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.27 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.28 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.29 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 3.30 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.31 s
                 \omega_R = 202.00 \text{ rad/s} \quad \omega_L = 198.00 \text{ rad/s}
t = 3.32 s
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 3.33 s
t = 3.34 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 3.35 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.36 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 3.37 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 3.38 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 3.39 s
                     \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 3.40 s
                     \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.41 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 3.42 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.43 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.44 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.45 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.46 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.47 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.48 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.49 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.50 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.51 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.52 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.53 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 3.54 s
t = 3.55 s
                 |\omega_R| = 202.00 \text{ rad/s} |\omega_L| = 198.00 \text{ rad/s}
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 3.56 s
t = 3.57 \text{ s} \mid \omega_R = 202.00 \text{ rad/s}
                                                     \omega_L = 198.00 \text{ rad/s}
t = 3.58 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.59 s
                    \omega R = 202.00 rad/s
                                                    | \omega L = 198.00 \text{ rad/s}
t = 3.60 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.61 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.62 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.63 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.64 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.65 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.66 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 3.67 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.68 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 3.69 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.70 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.71 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.72 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.73 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
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```
t = 3.74 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.75 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.76 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 3.77 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 3.78 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 3.79 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 3.80 s
                | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 3.81 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.82 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.83 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.84 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.85 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.86 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.87 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 3.88 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.89 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.90 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.91 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.92 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 3.93 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 3.94 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 3.95 s
                \omega_R = 202.00 \text{ rad/s} \quad \omega_L = 198.00 \text{ rad/s}
t = 3.96 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 3.97 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 3.98 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 3.99 s
t = 4.00 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.01 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.02 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.03 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.04 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.05 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.06 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.07 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.08 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.09 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.10 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.11 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.12 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 4.13 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.14 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.15 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.16 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.17 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.18 s
                 \omega_R = 202.00 \text{ rad/s}
                                                 \omega_L = 198.00 \text{ rad/s}
t = 4.19 s
                 \omega_R = 202.00 \text{ rad/s}
                                                 | \omega_L = 198.00 \text{ rad/s}
t = 4.20 s
                 \omega_R = 202.00 \text{ rad/s}
                                                 \omega_L = 198.00 \text{ rad/s}
t = 4.21 s
                 \omega_R = 202.00 \text{ rad/s}
                                                 \omega_L = 198.00 \text{ rad/s}
t = 4.22 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.23 s
                   \omega R = 202.00 rad/s
                                                 | \omega L = 198.00 \text{ rad/s}
t = 4.24 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.25 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.26 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.27 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.28 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.29 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.30 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.31 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 4.32 s
                | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 4.33 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 4.34 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 4.35 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 4.36 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.37 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
```

```
t = 4.38 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.39 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 4.40 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 4.41 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 4.42 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.43 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 4.44 s
                | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 4.45 s
                \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 4.46 s
                | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 4.47 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.48 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.49 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.50 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.51 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.52 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.53 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.54 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 4.55 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 4.56 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 4.57 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.58 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.59 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.60 s
                \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 4.61 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.62 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.63 s
t = 4.64 s
                   \omega R = 202.00 rad/s
                                                   \omega L = 198.00 \text{ rad/s}
t = 4.65 s
                   \omega R = 202.00 rad/s
                                                   \omega L = 198.00 \text{ rad/s}
t = 4.66 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.67 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.68 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.69 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.70 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.71 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.72 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.73 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.74 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.75 s
                |\omega_R| = 202.00 \text{ rad/s} |\omega_L| = 198.00 \text{ rad/s}
t = 4.76 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 4.77 s
                |\omega_R| = 202.00 \text{ rad/s} |\omega_L| = 198.00 \text{ rad/s}
t = 4.78 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.79 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.80 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.81 s
                \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 4.82 s
                 \omega_R = 202.00 \text{ rad/s}
                                                 \omega_L = 198.00 \text{ rad/s}
                 \omega_R = 202.00 \text{ rad/s}
                                                 | \omega_L = 198.00 \text{ rad/s}
t = 4.83 s
t = 4.84 s
                 \omega_R = 202.00 \text{ rad/s}
                                                 \omega_L = 198.00 \text{ rad/s}
t = 4.85 s
                 \omega_R = 202.00 \text{ rad/s}
                                                 \omega_L = 198.00 \text{ rad/s}
t = 4.86 s
                 \omega R = 202.00 rad/s
                                                 | \omega L = 198.00 \text{ rad/s}
t = 4.87 s
                   \omega R = 202.00 rad/s
                                                 | \omega L = 198.00 \text{ rad/s}
t = 4.88 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 4.89 s
                | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 4.90 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.91 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.92 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.93 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.94 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 4.95 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 4.96 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 4.97 s
                | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 4.98 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 4.99 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega \text{ L} = 198.00 \text{ rad/s}
t = 5.00 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.01 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
```

```
t = 5.02 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.03 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.04 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.05 s
                  \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 5.06 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.07 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.08 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.09 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.10 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.11 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.12 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.13 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.14 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.15 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 5.16 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.17 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.18 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.19 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.20 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.21 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.22 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 5.23 s
                 \omega_R = 202.00 \text{ rad/s} \quad \omega_L = 198.00 \text{ rad/s}
t = 5.24 s
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 5.25 s
t = 5.26 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.27 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.28 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.29 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.30 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.31 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.32 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.33 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.34 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.35 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.36 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.37 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.38 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.39 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.40 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.41 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.42 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.43 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.44 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.45 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.46 s
                  \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 5.47 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 5.48 s
t = 5.49 s
                  \omega_R = 202.00 \text{ rad/s}
                                                    \omega_L = 198.00 \text{ rad/s}
t = 5.50 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.51 s
                    \omega R = 202.00 rad/s
                                                   | \omega L = 198.00 \text{ rad/s}
t = 5.52 s
                   \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.53 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.54 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.55 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.56 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.57 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.58 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.59 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.60 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.61 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.62 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.63 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.64 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.65 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
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```
t = 5.66 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.67 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.68 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.69 s
                 \omega R = 202.00 rad/s \omega L = 198.00 rad/s
t = 5.70 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.71 s
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 5.72 \text{ s} \mid \omega \text{ R} = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.73 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.74 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.75 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.76 s
                 | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 5.77 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.78 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.79 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.80 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.81 s
                 |\omega_R| = 202.00 \text{ rad/s} |\omega_L| = 198.00 \text{ rad/s}
t = 5.82 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.83 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.84 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 5.85 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.86 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.87 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.88 s
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
                  | \omega_R = 202.00 \text{ rad/s} | \omega_L = 198.00 \text{ rad/s}
t = 5.89 s
                  | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 5.90 s
t = 5.91 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.92 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.93 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.94 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.95 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.96 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.97 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 5.98 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 5.99 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.00 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.01 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.02 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.03 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.04 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 6.05 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.06 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.07 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.08 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.09 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.10 s
                 \omega_R = 202.00 \text{ rad/s}
                                                   \omega_L = 198.00 \text{ rad/s}
                 \omega_R = 202.00 \text{ rad/s} \ \omega_L = 198.00 \text{ rad/s}
t = 6.11 s
t = 6.12 s
                 \omega_R = 202.00 \text{ rad/s}
                                                   \omega_L = 198.00 \text{ rad/s}
t = 6.13 s
                 \omega_R = 202.00 \text{ rad/s}
                                                   \omega_L = 198.00 \text{ rad/s}
t = 6.14 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 6.15 s
                    \omega R = 202.00 rad/s
                                                   | \omega L = 198.00 \text{ rad/s}
t = 6.16 s
                   \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.17 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.18 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.19 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.20 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.21 s
                    \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.22 s
                    \omega R = 202.00 rad/s | \omega L = 198.00 rad/s
t = 6.23 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 6.24 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 6.25 s
                 | \omega R = 202.00 \text{ rad/s} | \omega L = 198.00 \text{ rad/s}
t = 6.26 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.27 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
t = 6.28 \text{ s} \mid \omega_R = 202.00 \text{ rad/s} \mid \omega_L = 198.00 \text{ rad/s}
t = 6.29 \text{ s} \mid \omega R = 202.00 \text{ rad/s} \mid \omega L = 198.00 \text{ rad/s}
```

#### Simulacion virtual 3D

Tras la simulación cinemática, se configura un entorno 3D para visualizar el comportamiento del robot. Se crea una figura de tamaño completo con fondo blanco, se ajustan los ejes con proporciones iguales y se establecen etiquetas y cuadrículas para facilitar la lectura del entorno. Se coloca una luz en la escena y se orienta la vista para una mejor perspectiva. Los límites de visualización se establecen para acomodar el espacio que recorrerá el robot.

# a) Configuracion de escena

```
scene=figure; % Crear figura (Escena)
set(scene,'Color','white'); % Color del fondo de la escena
set(gca,'FontWeight','bold') ;% Negrilla en los ejes y etiquetas
sizeScreen=get(0,'ScreenSize'); % Retorna el tamaño de la pantalla del computador
set(scene,'position',sizeScreen); % Congigurar tamaño de la figura
camlight('headlight'); % Luz para la escena
axis equal; % Establece la relación de aspecto para que las unidades de datos sean
las mismas en todas las direcciones.
grid on; % Mostrar líneas de cuadrícula en los ejes
box on; % Mostrar contorno de ejes
xlabel('x(m)'); ylabel('y(m)'); zlabel('z(m)'); % Etiqueta de los eje

view([0 90]); % Orientacion de la figura
axis([-21 21 -21 21 0 2]); % Ingresar limites minimos y maximos en los ejes x y z
[minX maxX minY maxY minZ maxZ]
```

## b) Graficar robots en la posicion inicial

```
scale = 4;
MobileRobot_5;
H1=MobilePlot_4(x1(1),y1(1),phi(1),scale);hold on;
```

# c) Graficar Trayectorias

```
H2=plot3(hx(1),hy(1),0,'c','lineWidth',2);
```

## d) Bucle de simulacion de movimiento del robot

Se dibuja el robot en su posición inicial mediante una función externa (MobilePlot\_4) que toma como parámetros la posición, orientación y una escala de visualización. Luego, se dibuja la primera parte de la

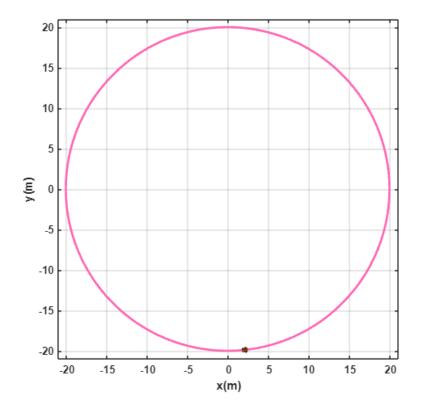
trayectoria del punto de control en color rojo. El bucle de simulación gráfica recorre los pasos definidos, actualizando la posición del robot y su trayectoria en cada iteración.

```
step=1; % pasos para simulacion

for k=1:step:N

    delete(H1);
    delete(H2);

H1=MobilePlot_4(x1(k),y1(k),phi(k),scale);
    H2=plot3(hx(1:k),hy(1:k),zeros(1,k),'Color', [1 0.4 0.7],'lineWidth',2);
    pause(ts);
end
```



# **Gráficas**

Finalmente, se calculan las velocidades de las ruedas derecha (wr) y izquierda (w1) utilizando las ecuaciones cinemáticas del robot diferencial, y se crean dos nuevas subgráficas. La primera muestra la velocidad de la rueda derecha, y la segunda, la velocidad de la rueda izquierda.

```
wr = (2*u + w*L) / (2*r);
wl = (2*u - w*L) / (2*r);
graph6 = figure;
```

```
set(graph6, 'position', sizeScreen);

subplot(2,1,1)
plot((0:N-1)*ts, wr, 'r', 'LineWidth', 2);
xlabel('Tiempo [s]'); ylabel('x [m]');
title('Velocidad rueda derecha (WR)');
grid on;

subplot(2,1,2)
plot((0:N-1)*ts, wl, 'b', 'LineWidth', 2);
xlabel('Tiempo [s]'); ylabel('y [m]');
title('Velocidad rueda izquierda (WL)');
grid on;
```

