- **Intorduction:**

Laser cutting of sheet metals has several advantages over conventional cutting methods. Some of these advantages include high-speed and local processing, precision of operation, low cutting waste, and net shaping. However, laser cutting faces problems when processing difficult-to-cut materials. This is because of the fact that localized heating, due to the laser irradiation at the surface, can be suppressed by the reflectivity of the substrates or heat dissipation because of high thermal conductivity. In addition, laser cutting of ceramics is challenging because of the thermally-induced cracking generated during the laser-cutting process. In the laser-cutting process, the end product is highly-dependent on the proper selection of the laser parameters and the work piece material properties such that the high quality of the desired end product is ensured. One of the high-thermal conductivity materials of the metallic substrate is bronze, which is used in bearing applications due to its low friction coefficient. Because laser cutting is involved with high-temperature processing, temperature gradients developed in the cutting region result in high-thermal stresses. Depending on the mechanical properties of the substrate material used, cracks can be formed at the cut surfaces, limiting the practical application of the laser cut components. Consequently, the investigation into laser cutting of difficult-to-cut materials becomes essential. This, in turn, provides useful information on the machining capability lasers in practical applications.

Laser cutting of composites finds wide application in industry due to improved end-product quality, low cost, and short processing time. The end-product quality is influenced significantly by the high-temperature combustion reactions taking place in the cutting section. Moreover, when cutting thick work pieces, the assisting gas may not have enough pressure to shield the cutting edges from the combustion reactions when it reaches the bottom of the work piece. This, in turn, results in sideways burning at the bottom edge of the work piece. Therefore, investigation into the end-product quality of laser cutting of composites is necessary. The findings of laser cutting of a work piece composed of 64 layers of plain-weave carbon/carbon fibers with 00 orientation carbon/carbon fibers structured are presented herein.

- **Working principle**

Laser cutting works by directing the output of a high-power laser most commonly through optics. The laser optics and CNC (computer numerical control) is used to direct the laser beam to the material. A commercial laser for cutting materials uses a motion control system to follow a CNC or G-code of the pattern that is to be cut onto the material. The focused laser beam is directed at the material, which then either melts, burns, vaporizes away, or is blown away by a jet of gas, leaving an edge with a high-quality surface finish. When cutting mild steel, pure oxygen is released to start a burning process. In the case of stainless steel or laser cutting aluminum, the laser beam just melts the metal. The cutting gas is then nitrogen, to blow out the molten metal and keep the cuts clean.

Laser cutting machine steel is to focus the laser light emitted from the laser into a high power density laser beam through the optical path system. The laser beam irradiates the surface of the work piece to make the work piece reach the melting point or boiling point, and the high-pressure gas coaxial with the beam blows away the molten or vaporized metal. As the relative position of the beam and the work piece moves, the material will eventually form a slit, so as to achieve the purpose of cutting

- **Code explainations**

1:- % Define the functions

t = 0:0.01:30;

This command defines the time range for the signals. It creates a vector t that goes from 0 to 30 seconds with 1000 equally spaced points.

2:- % Define the signals

x = 2 + r(t) - 0.293*r(3*(t-3)) - 1.414*r(4.41*(t-4.41)) - 0.293*r(5.828*(t-5.828)) + r(t-6.828) + r(t-7.828) - 0.413*r(t-9.828) + 0.143*r(t-15.659) - r(t-17.659) - r(t-20.659) + 0.106*r(t-22.659) - 0.106*r(t-27.012) + r(t-32.012);

This calculates the x position of the laser head as a function of time t using a series of signal processing operations involving the function r(t).

y = 7 - 0.707*r(t-3) + 0.707*r(5.828*(t-5.828)) - r(t-6.828) + r(t-7.828) + 0.515*r(t-9.828) - 0.515*r(t-15.659) - r(t-17.659) + r(t-19.659) - r(t-20.659) + r(t-22.659) - 0.247*r(t-27.012) + 0.247*r(t-32.012);

This calculates the y position of the laser head as a function of time t using a series of signal processing operations involving the function r(t).

3:- % Plot the signals

figure;

plot(t, x, 'LineWidth', 2);

hold on;

plot(t, y, 'LineWidth', 2);

xlabel('Time (s)');

ylabel('Signal Amplitude');

title('Signals x(t) and y(t)');

legend('x(t)', 'y(t)');

These commands plot the signals x and y using the plot function. The hold on command is used to plot both signals on the same figure. The xlabel, ylabel, title, and legend commands are used to label the plot.

4:- % Plot y(t) versus x(t)

```
figure;

plot(x,y)

xlabel('x(t)')

ylabel('y(t)')

title('Shape Cut Out')
```

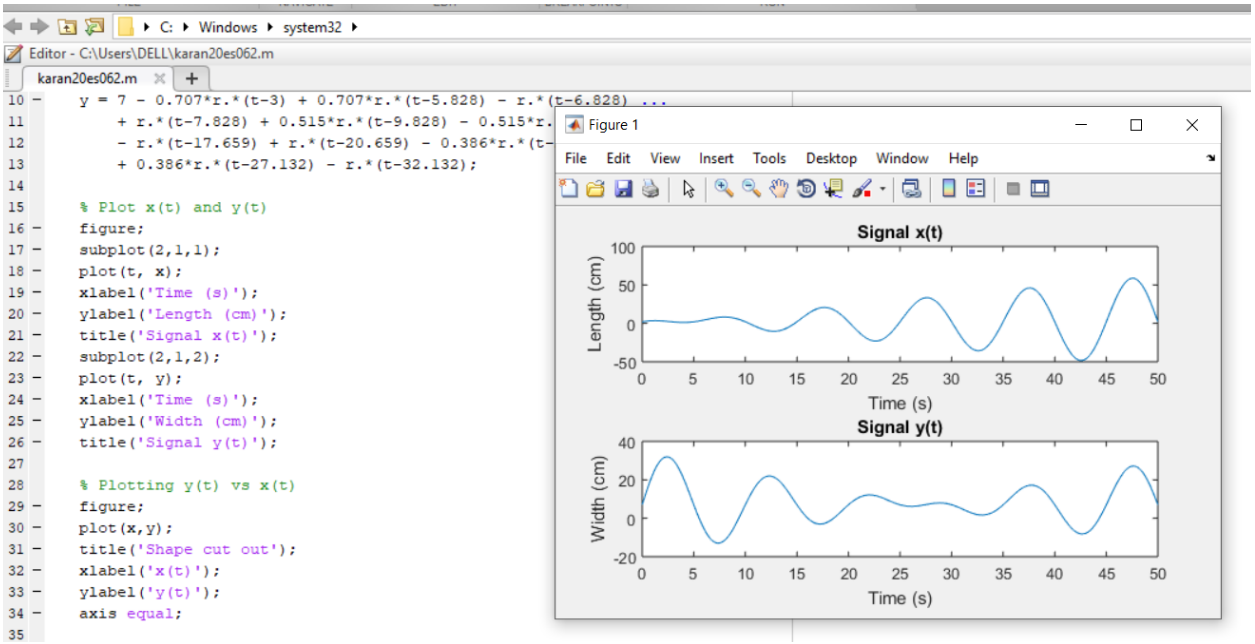
This command plots the shape cut out using the plot function. The xlabel, ylabel, and title commands are used to label the plot.

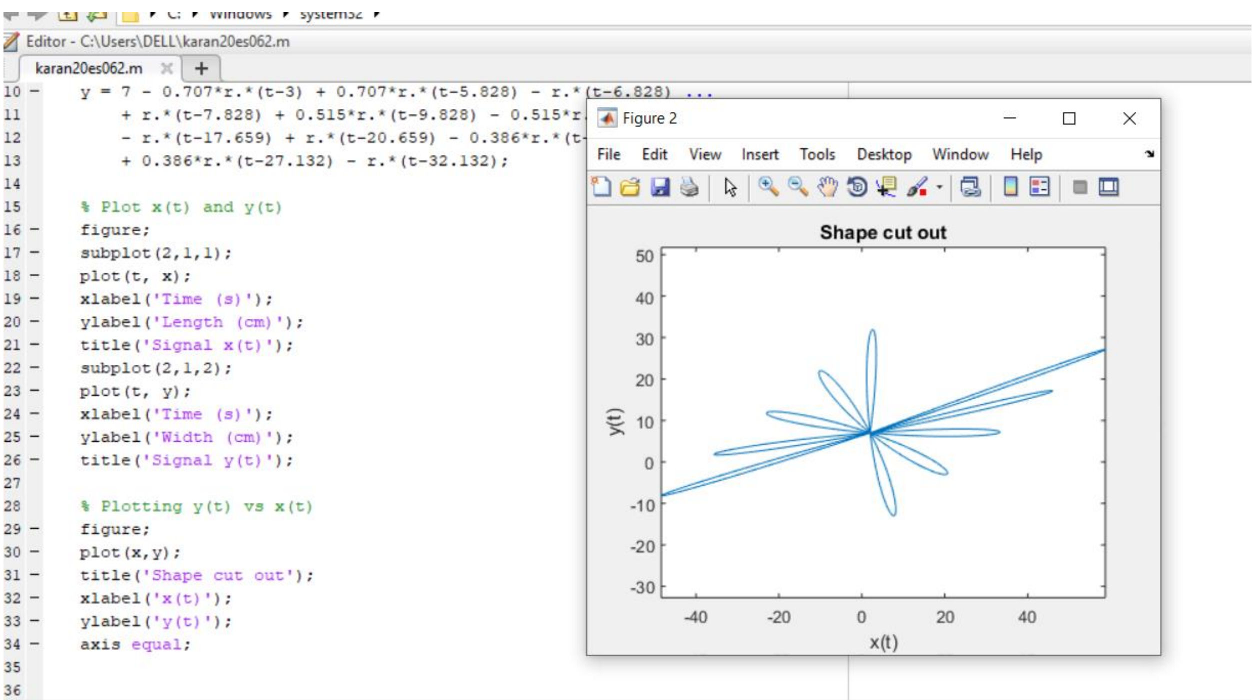
5:- % Calculate the length of the cutout path

```
path_length = 0;

for i = 2:length(x)

   dx = x(i) - x(i-1);

   dy = y(i) - y(i-1);

   path_length = path_length + sqrt(dx^2 + dy^2);

end

% Calculate the time required for laser cutting

speed = 500; % mm/s (assumed speed of laser head)

cutting_time = path_length / speed;

disp(['Time required for laser cutting: ', num2str(cutting_time), ' s'])
```

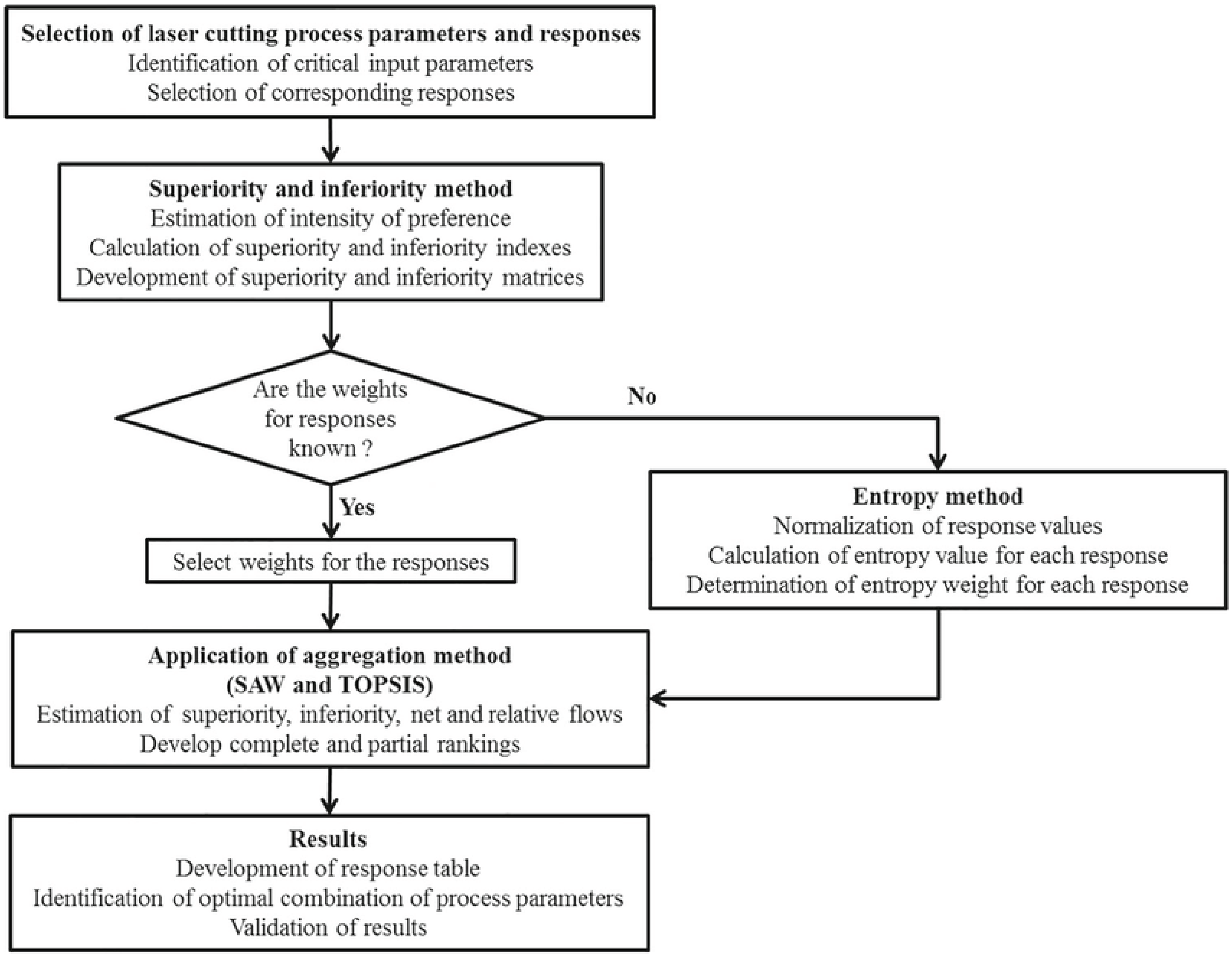
This calculates the total time required for the laser cutting as the difference between the last and first time points in the t array.

- **Results:-**


C: ▸ Windows ▸ system32 ▸
Editor - C:\Users\DELL\karan20es062.m
karan20es062.m
y = 7 - 0.707*r.*(t-3) + 0.707*r.*(t-5.828) - r.*(t-6.828) ...
+ r.*(t-7.828) + 0.515*r.*(t-9.828) - 0.515*r.
- r.*(t-17.659) + r.*(t-20.659) - 0.386*r.*(t-
+ 0.386*r.*(t-27.132) - r.*(t-32.132);
% Plot x(t) and y(t)
figure;
subplot(2,1,1);
plot(t, x);
xlabel('Time (s)');
ylabel('Length (cm)');
title('Signal x(t)');
subplot(2,1,2);
plot(t, y);
xlabel('Time (s)');
ylabel('Width (cm)');
title('Signal y(t)');
% Plotting y(t) vs x(t)
figure;
plot(x,y);
title('Shape cut out');
xlabel('x(t)');
ylabel('y(t)');
axis equal;
Figure 1
File Edit View Insert Tools Desktop Window Help
Signal x(t)
Length (cm)
Time (s)
Signal y(t)
Width (cm)
Time (s)


Editor - C:\Users\DELL\karan20es062.m
karan20es062.m
y = 7 - 0.707*r.*(t-3) + 0.707*r.*(t-5.828) - r.*(t-6.828) ...
+ r.*(t-7.828) + 0.515*r.*(t-9.828) - 0.515*r.
- r.*(t-17.659) + r.*(t-20.659) - 0.386*r.*(t-
+ 0.386*r.*(t-27.132) - r.*(t-32.132);
% Plot x(t) and y(t)
figure;
subplot(2,1,1);
plot(t, x);
xlabel('Time (s)');
ylabel('Length (cm)');
title('Signal x(t)');
subplot(2,1,2);
plot(t, y);
xlabel('Time (s)');
ylabel('Width (cm)');
title('Signal y(t)');
% Plotting y(t) vs x(t)
figure;
plot(x,y);
title('Shape cut out');
xlabel('x(t)');
ylabel('y(t)');
axis equal;
Figure 2
File Edit View Insert Tools Desktop Window Help
Shape cut out
y(t)
x(t)

Flow chart



Flow chart steps:-

1:-Inputs:

The dimensions of the steel stock (15cm x 9cm x 6mm)

The control signals for the laser cutting tool in the x and y directions

2:-Process step:-

Input the dimensions of the steel stock (15cm x 9cm x 6mm).

Input the control signals for the laser cutting tool in the x and y directions.

Use the laser cutting tool to cut the desired shape from the steel stock, using the control signals to guide the tool.

Output the cut part from the steel stock with the desired dimensions and shape.

3:-Outputs:

The cut part from the steel stock with the desired dimensions and shape

Refrence:

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