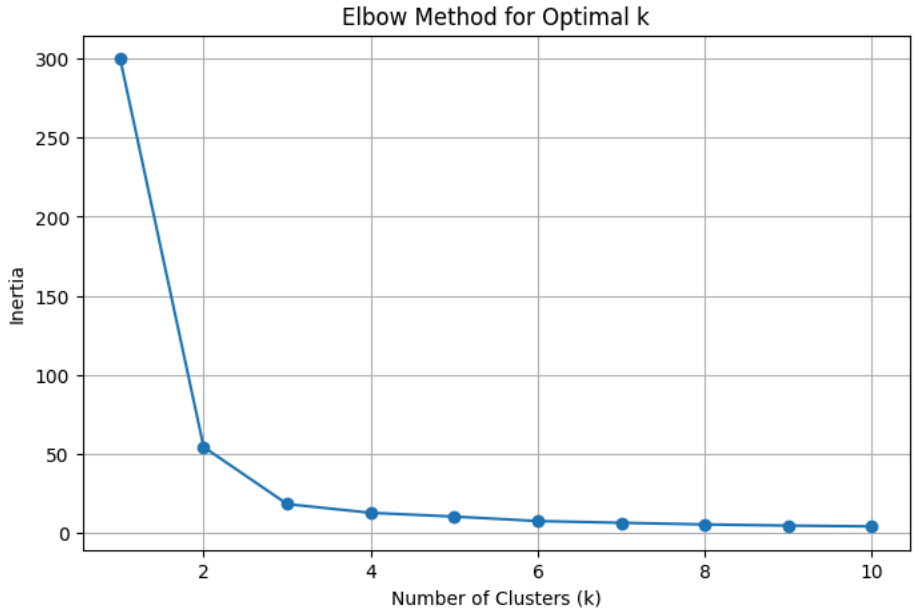
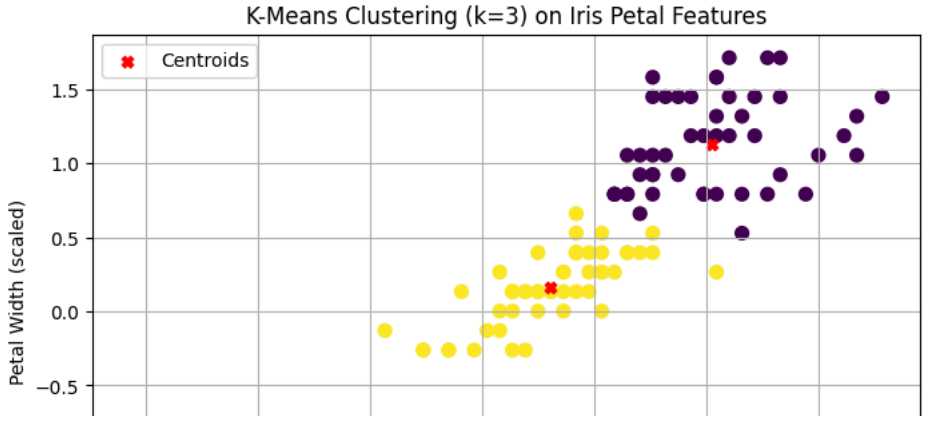
```
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans

# Load your iris dataset
df = pd.read_csv("iris.csv")

# Use only Petal Length and Petal Width
X = df[["petal_length", "petal_width"]]

# Scale the features
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

# Elbow Method to determine optimal k
inertia = []
k_range = range(1, 11)

for k in k_range:
    kmeans = KMeans(n_clusters=k, random_state=42)
    kmeans.fit(X_scaled)
    inertia.append(kmeans.inertia_)

# Plot Elbow Curve
plt.figure(figsize=(8, 5))
plt.plot(k_range, inertia, marker='o')
plt.title("Elbow Method for Optimal k")
plt.xlabel("Number of Clusters (k)")
plt.ylabel("Inertia")
plt.grid(True)
plt.show()

# Final KMeans with optimal k (e.g., 3 from elbow)
optimal_k = 3
kmeans = KMeans(n_clusters=optimal_k, random_state=42)
df['Cluster'] = kmeans.fit_predict(X_scaled)

# Visualize Clusters
plt.figure(figsize=(8, 5))
plt.scatter(X_scaled[:, 0], X_scaled[:, 1], c=df['Cluster'], cmap='viridis', s=50)
plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1],
            color='red', marker='X', label='Centroids')
plt.xlabel("Petal Length (scaled)")
plt.ylabel("Petal Width (scaled)")
plt.title(f"K-Means Clustering (k={optimal_k}) on Iris Petal Features")
plt.legend()
plt.grid(True)
plt.show()
```


Elbow Method for Optimal k
Inertia
Number of Clusters (k)
300
250
200
150
100
50
0
2
4
6
8
10


K-Means Clustering (k=3) on Iris Petal Features
Centroids
Petal Width (scaled)
1.5
1.0
0.5
0.0
−0.5