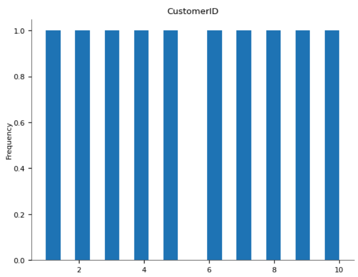
In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.cluster import KMeans
from sklearn.decomposition import PCA
```

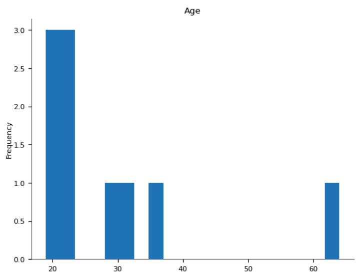
In [3]:
```
mall = pd.read_csv('Mall_Customers.csv')
mall.head(10)
```

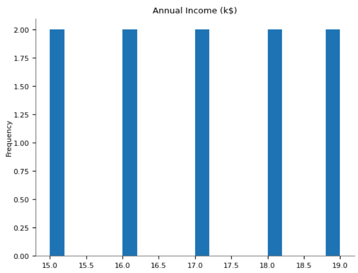
Out[3]:

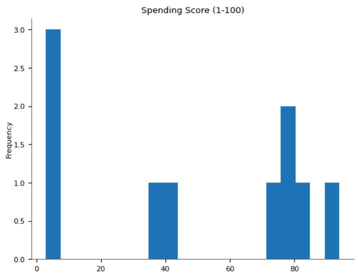
	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)
0	1	Male	19	15	39
1	2	Male	21	15	81
2	3	Female	20	16	6
3	4	Female	23	16	77
4	5	Female	31	17	40
5	6	Female	22	17	76
6	7	Female	35	18	6
7	8	Female	23	18	94
8	9	Male	64	19	3
9	10	Female	30	19	72

Distributions

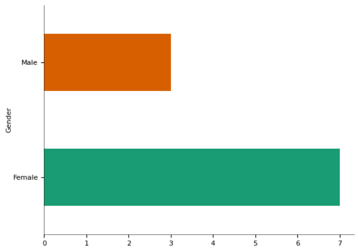




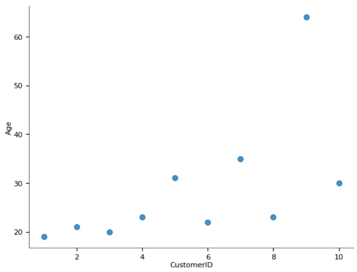


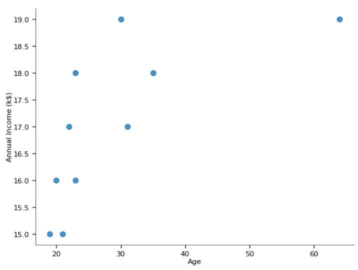


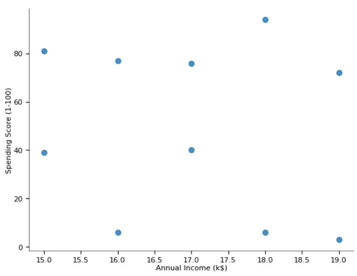
Categorical distributions



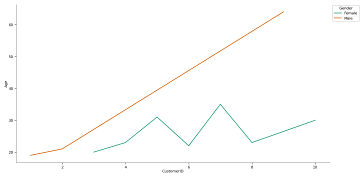
2-d distributions

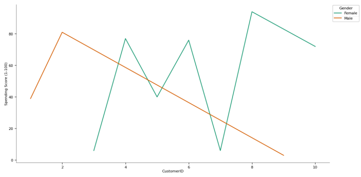


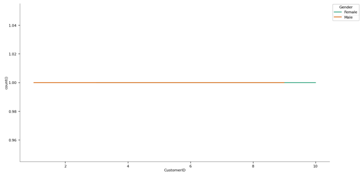


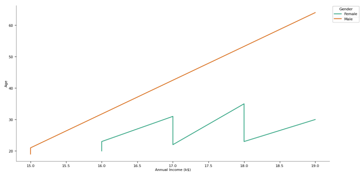


Time series

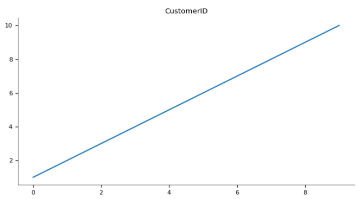


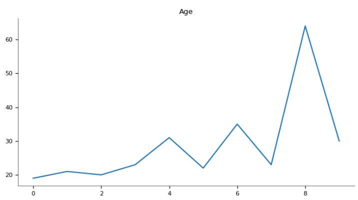


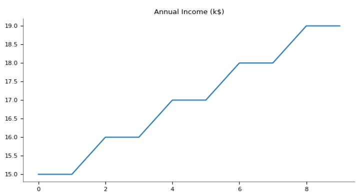


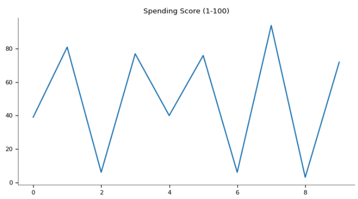


Values



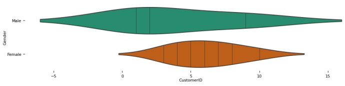




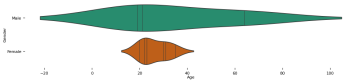


Faceted distributions

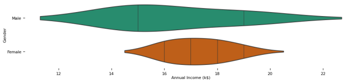
```
<string>:5: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v
0.14.0. Assign the `y` variable to `hue` and set `legend=False` for the same effe
ct.
```



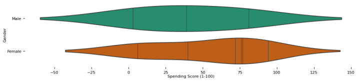
```
<string>:5: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v
0.14.0. Assign the `y` variable to `hue` and set `legend=False` for the same effe
ct.
```



```
<string>:5: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v
0.14.0. Assign the `y` variable to `hue` and set `legend=False` for the same effe
ct.
```



```
<string>:5: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v
0.14.0. Assign the `y` variable to `hue` and set `legend=False` for the same effe
ct.
```



In [4]:
```
len(mall)
```

Out[4]:
```
200
```

In [7]:
```
mall['CustomerID'].nunique()
```

Out[7]:
```
200
```

In [6]:
```
len(mall[mall.duplicated()])
```

Out[6]:
```
0
```

In [8]:
```
mall.isnull().sum()
```

Out[8]:
```
CustomerID                0
Gender                    0
Age                       0
Annual Income (k$)        0
Spending Score (1-100)    0
dtype: int64
```

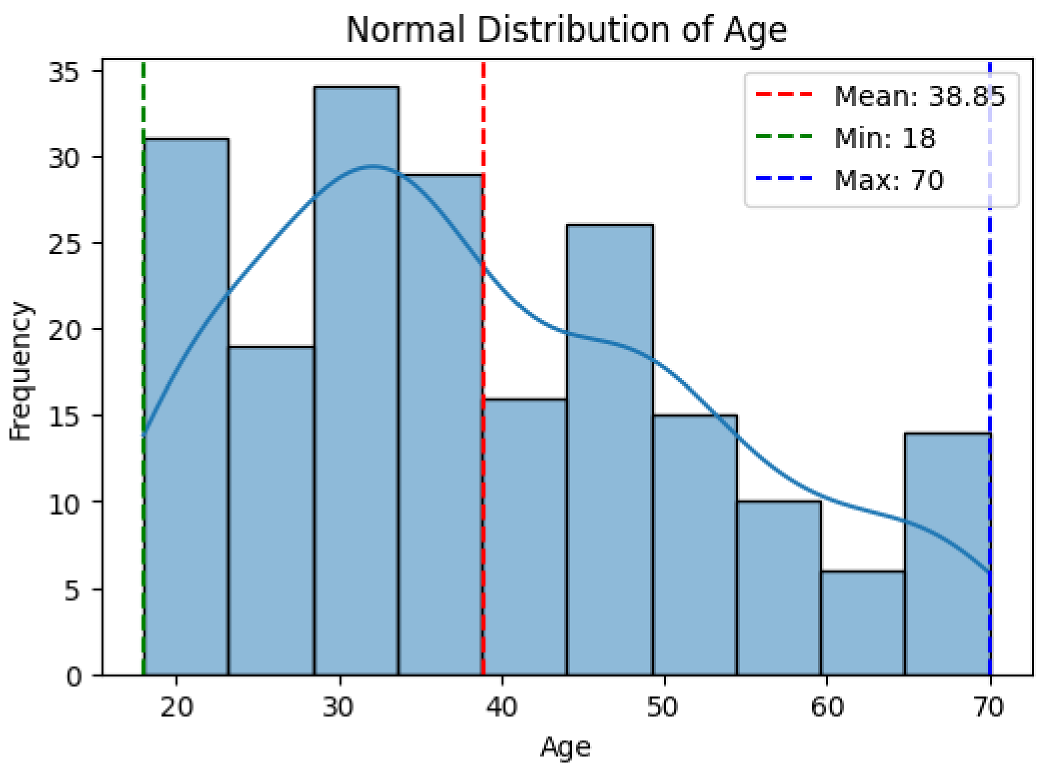
In [9]:
```
mall.drop(columns=['CustomerID'] , inplace=True)
mall.head(10)
```

Out[9]:

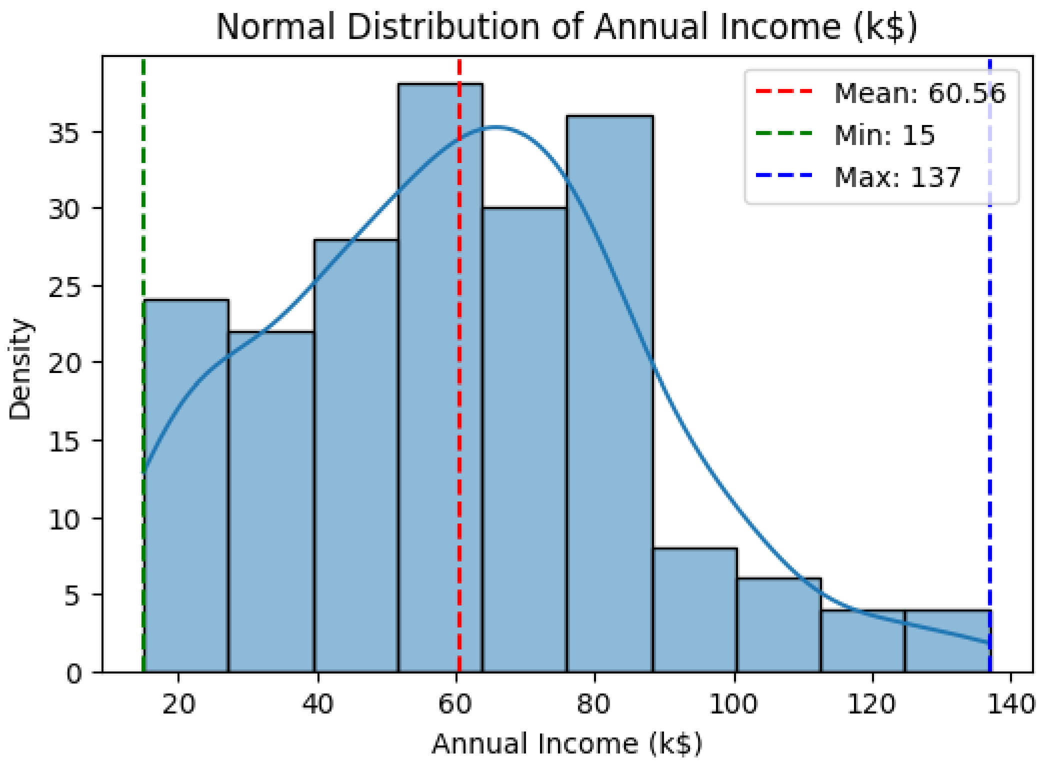
	Gender	Age	Annual Income (k$)	Spending Score (1-100)
0	Male	19	15	39
1	Male	21	15	81
2	Female	20	16	6
3	Female	23	16	77
4	Female	31	17	40
5	Female	22	17	76
6	Female	35	18	6
7	Female	23	18	94
8	Male	64	19	3
9	Female	30	19	72

In [10]:

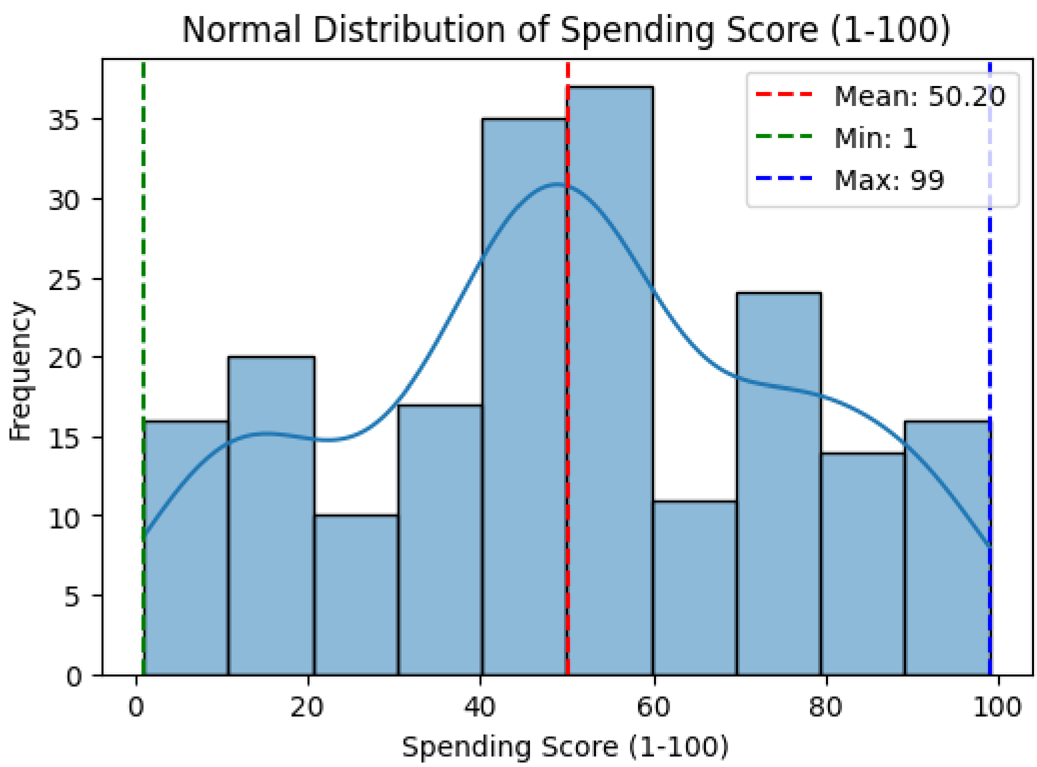
```
mean_age = mall['Age'].mean()
min_age = mall['Age'].min()
max_age = mall['Age'].max()

# Plotting the normal distribution for 'Age'
plt.figure(figsize=(6, 4))
sns.histplot(mall['Age'], kde=True, bins=10)
plt.axvline(mean_age, color='r', linestyle='--', label=f'Mean: {mean_age:.2f}')
plt.axvline(min_age, color='g', linestyle='--', label=f'Min: {min_age}')
plt.axvline(max_age, color='b', linestyle='--', label=f'Max: {max_age}')

# Add titles and labels
plt.title('Normal Distribution of Age')
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.legend()

# Show plot
plt.show()
```



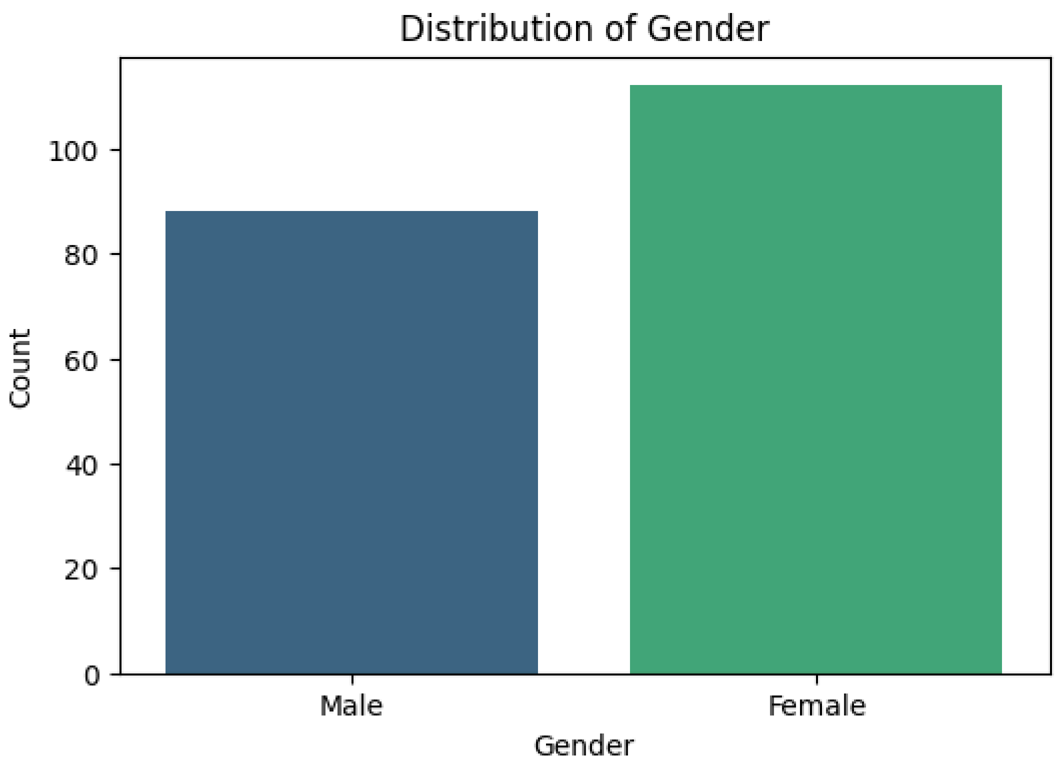
In [11]:
```
mean_income = mall['Annual Income (k$)'].mean()
min_income = mall['Annual Income (k$)'].min()
max_income = mall['Annual Income (k$)'].max()

# Plotting the normal distribution for 'Annual Income (k$)'
plt.figure(figsize=(6, 4))
sns.histplot(mall['Annual Income (k$)'], kde=True)
plt.axvline(mean_income, color='r', linestyle='--', label=f'Mean: {mean_income}'
plt.axvline(min_income, color='g', linestyle='--', label=f'Min: {min_income}')
plt.axvline(max_income, color='b', linestyle='--', label=f'Max: {max_income}')

# Add titles and labels
plt.title('Normal Distribution of Annual Income (k$)')
plt.xlabel('Annual Income (k$)')
plt.ylabel('Density')
plt.legend()

# Show plot
plt.show()
```



In [12]:
```
mean_score = mall['Spending Score (1-100)'].mean()
min_score = mall['Spending Score (1-100)'].min()
max_score = mall['Spending Score (1-100)'].max()

# Plotting the normal distribution for 'Spending Score (1-100)'
plt.figure(figsize=(6, 4))
sns.histplot(mall['Spending Score (1-100)'], kde=True, bins=10)
plt.axvline(mean_score, color='r', linestyle='--', label=f'Mean: {mean_score:.2f
plt.axvline(min_score, color='g', linestyle='--', label=f'Min: {min_score}')
plt.axvline(max_score, color='b', linestyle='--', label=f'Max: {max_score}')

# Add titles and labels
plt.title('Normal Distribution of Spending Score (1-100)')
plt.xlabel('Spending Score (1-100)')
plt.ylabel('Frequency')
plt.legend()

# Show plot
plt.show()
```

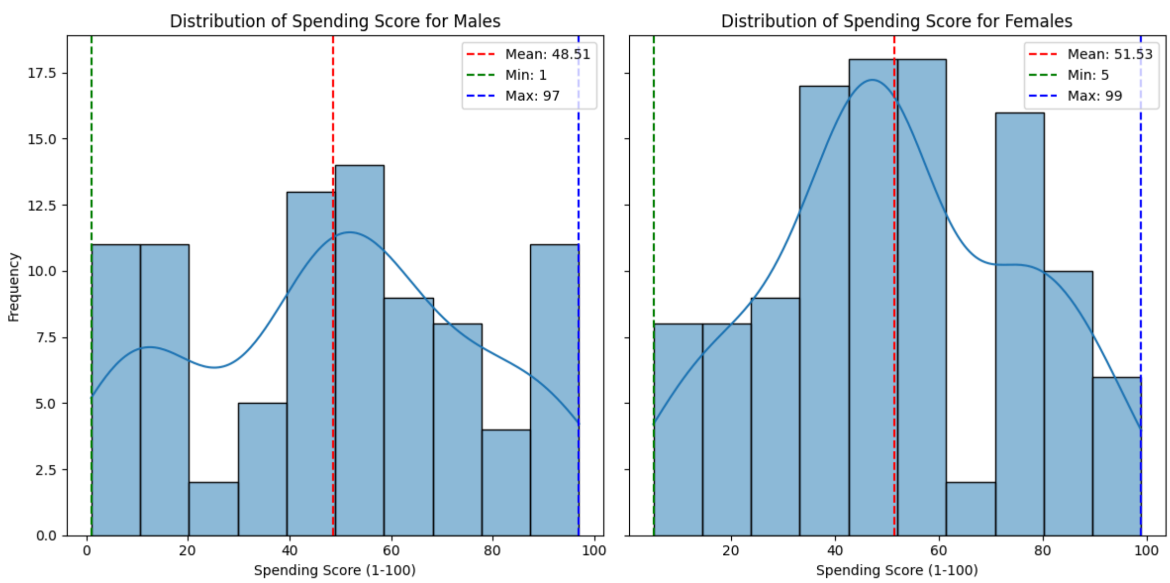


In [13]:
```
plt.figure(figsize=(6, 4))
sns.countplot(x='Gender', data=mall, hue='Gender', palette='viridis', legend=Fal
plt.title('Distribution of Gender')
plt.xlabel('Gender')
plt.ylabel('Count')
plt.show()
```



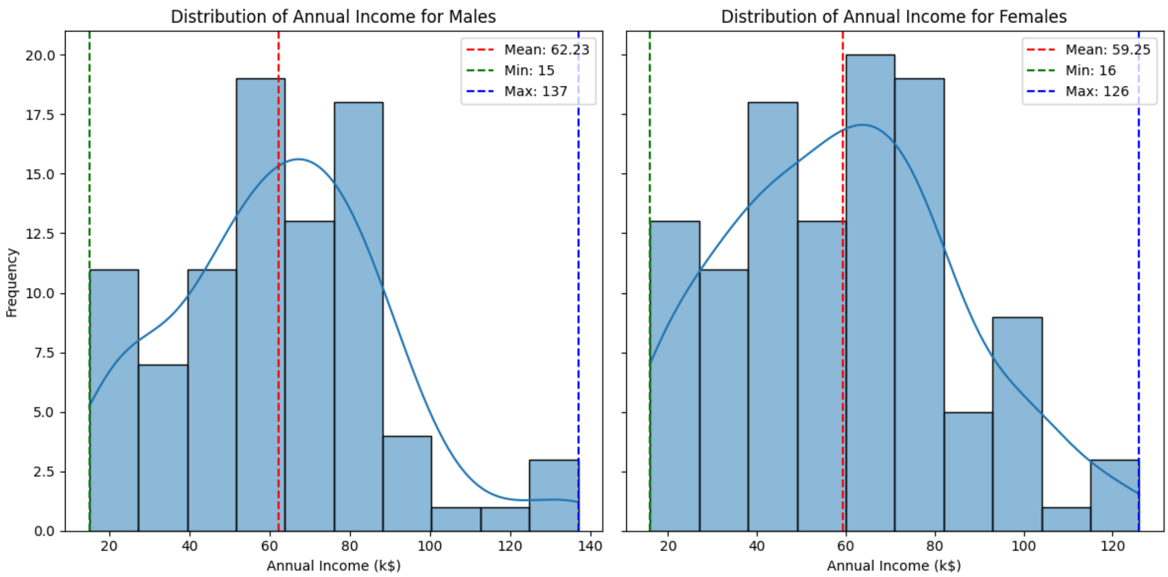
In [14]:
```
fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(12, 6), sharey=True)

# List of gender values and labels
genders = ['Male', 'Female']
labels = ['Males', 'Females']
```

```
for ax, gender, label in zip(axes, genders, labels):
    # Calculate mean, min, and max for 'Spending Score (1-100)'
    mean_score = mall['Spending Score (1-100)'][mall['Gender'] == gender].mean()
    min_score = mall['Spending Score (1-100)'][mall['Gender'] == gender].min()
    max_score = mall['Spending Score (1-100)'][mall['Gender'] == gender].max()

    # Plotting the distribution
    sns.histplot(mall['Spending Score (1-100)'][mall['Gender'] == gender], kde=T
    ax.axvline(mean_score, color='r', linestyle='--', label=f'Mean: {mean_score:
    ax.axvline(min_score, color='g', linestyle='--', label=f'Min: {min_score}')
    ax.axvline(max_score, color='b', linestyle='--', label=f'Max: {max_score}')
    ax.set_title(f'Distribution of Spending Score for {label}')
    ax.set_xlabel('Spending Score (1-100)')
    ax.set_ylabel('Frequency')
    ax.legend()

# Adjust layout and show plot
plt.tight_layout()
plt.show()
```

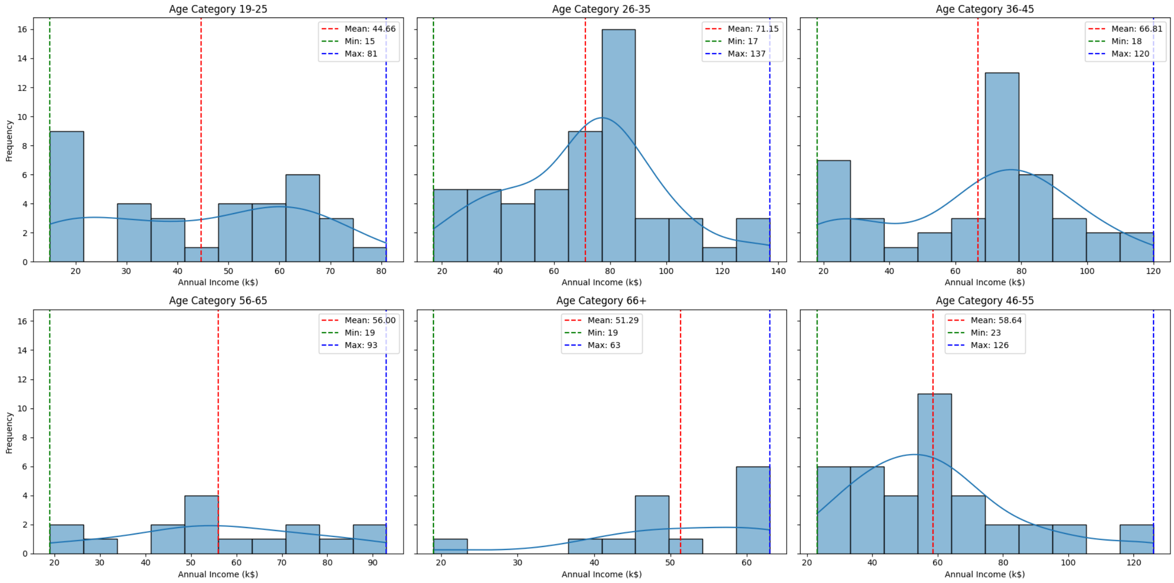


In [15]:
```
fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(12, 6), sharey=True)

# List of gender values and labels
genders = ['Male', 'Female']
labels = ['Males', 'Females']

for ax, gender, label in zip(axes, genders, labels):
    # Calculate mean, min, and max for 'Annual Income (k$)'
    mean_income = mall['Annual Income (k$)'][mall['Gender'] == gender].mean()
    min_income = mall['Annual Income (k$)'][mall['Gender'] == gender].min()
    max_income = mall['Annual Income (k$)'][mall['Gender'] == gender].max()

    # Plotting the distribution
    sns.histplot(mall['Annual Income (k$)'][mall['Gender'] == gender], kde=True,
    ax.axvline(mean_income, color='r', linestyle='--', label=f'Mean: {mean_incom
    ax.axvline(min_income, color='g', linestyle='--', label=f'Min: {min_income}'
    ax.axvline(max_income, color='b', linestyle='--', label=f'Max: {max_income}'
    ax.set_title(f'Distribution of Annual Income for {label}')
    ax.set_xlabel('Annual Income (k$)')
    ax.set_ylabel('Frequency')
    ax.legend()
```

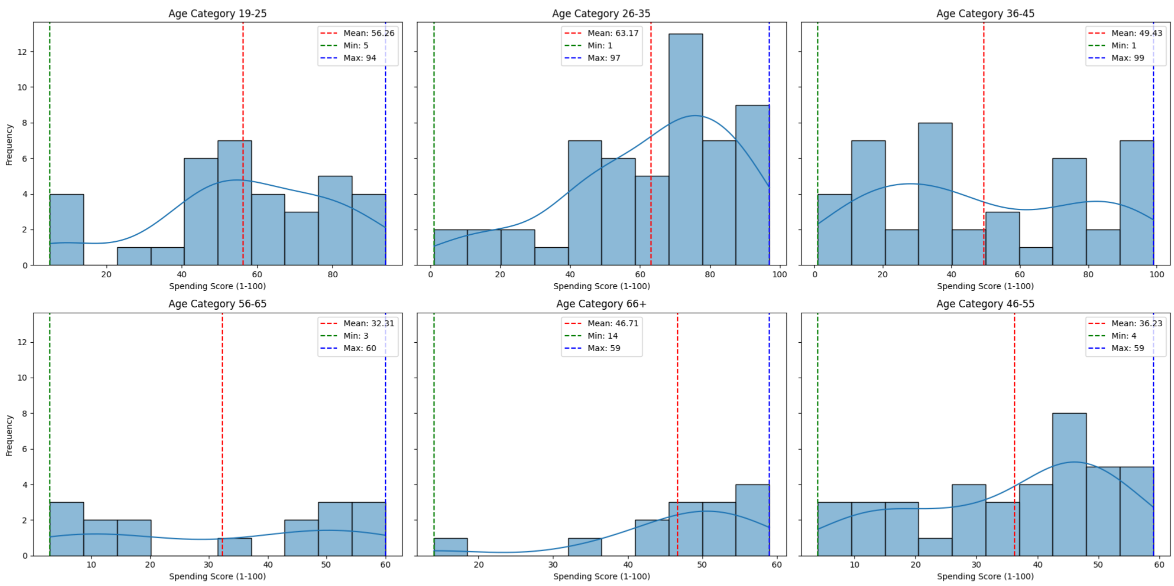
```
# Adjust layout and show plot
plt.tight_layout()
plt.show()
```



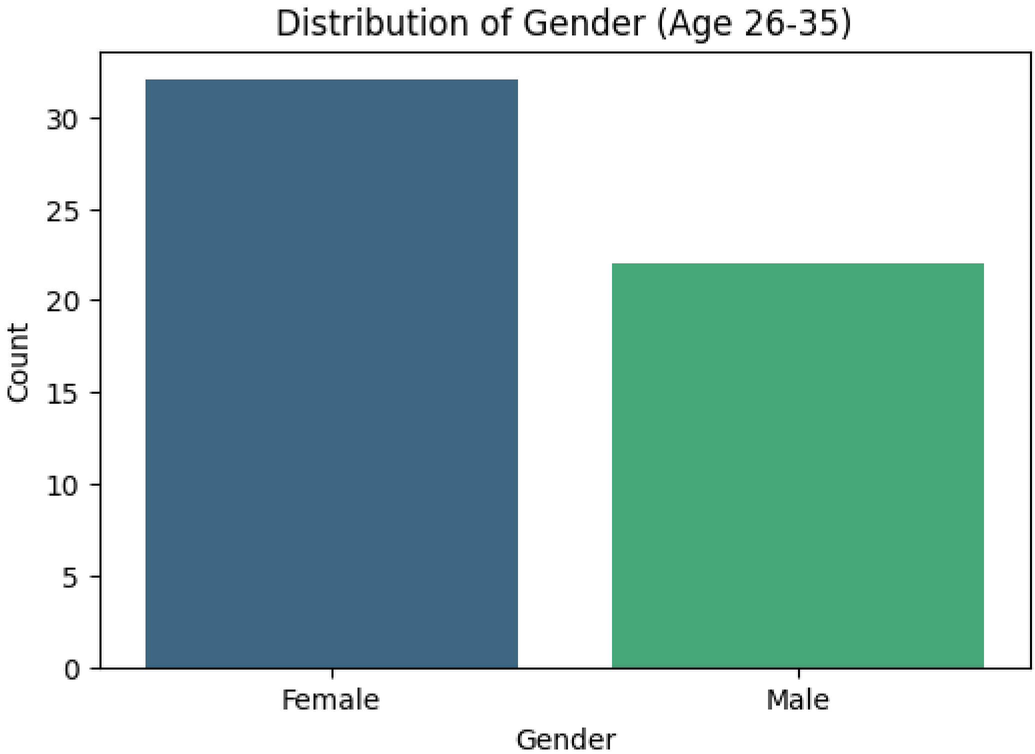
In [16]:
```
bins = [0, 18, 25, 35, 45, 55, 65, 100]
labels = ['0-18', '19-25', '26-35', '36-45', '46-55', '56-65', '66+']
mall['Age Category'] = pd.cut(mall['Age'], bins=bins, labels=labels, right=False

# Get unique age categories
age_categories = mall['Age Category'].unique()

# Prepare the figure and axes
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(20, 10), sharey=True)
axes = axes.flatten()  # Flatten the 2D array of axes to make it easier to itera

# Plotting each age category
for ax, category in zip(axes, age_categories):
    # Calculate mean, min, and max for 'Annual Income (k$)' based on age categor
    mean_income = mall['Annual Income (k$)'][mall['Age Category'] == category].m
    min_income = mall['Annual Income (k$)'][mall['Age Category'] == category].mi
    max_income = mall['Annual Income (k$)'][mall['Age Category'] == category].ma

    # Plotting the distribution
    sns.histplot(mall['Annual Income (k$)'][mall['Age Category'] == category], k
    ax.axvline(mean_income, color='r', linestyle='--', label=f'Mean: {mean_incom
    ax.axvline(min_income, color='g', linestyle='--', label=f'Min: {min_income}'
    ax.axvline(max_income, color='b', linestyle='--', label=f'Max: {max_income}'
    ax.set_title(f'Age Category {category}')
    ax.set_xlabel('Annual Income (k$)')
    ax.set_ylabel('Frequency')
    ax.legend()

# Adjust layout and show plot
plt.tight_layout()
plt.show()
```



In [17]:
```
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(20, 10), sharey=True)
axes = axes.flatten()  # Flatten the 2D array of axes to make it easier to itera

# Plotting each age category
for ax, category in zip(axes, age_categories):
    # Calculate mean, min, and max for 'Spending Score (1-100)' based on age cat
    mean_score = mall['Spending Score (1-100)'][mall['Age Category'] == category
    min_score = mall['Spending Score (1-100)'][mall['Age Category'] == category]
    max_score = mall['Spending Score (1-100)'][mall['Age Category'] == category]

    # Plotting the distribution
    sns.histplot(mall['Spending Score (1-100)'][mall['Age Category'] == category
    ax.axvline(mean_score, color='r', linestyle='--', label=f'Mean: {mean_score:
    ax.axvline(min_score, color='g', linestyle='--', label=f'Min: {min_score}')
    ax.axvline(max_score, color='b', linestyle='--', label=f'Max: {max_score}')
    ax.set_title(f'Age Category {category}')
    ax.set_xlabel('Spending Score (1-100)')
    ax.set_ylabel('Frequency')
    ax.legend()

# Adjust layout and show plot
plt.tight_layout()
plt.show()
```



In [18]:
```
filtered_mall = mall[mall['Age Category'] == '26-35']

# Plotting the distribution of gender for the '26-35' age category
plt.figure(figsize=(6, 4))
sns.countplot(x='Gender', data=filtered_mall, palette='viridis', hue='Gender', l
plt.title('Distribution of Gender (Age 26-35)')
plt.xlabel('Gender')
plt.ylabel('Count')
plt.show()

mall.drop(columns=['Age Category'] , inplace=True)
```

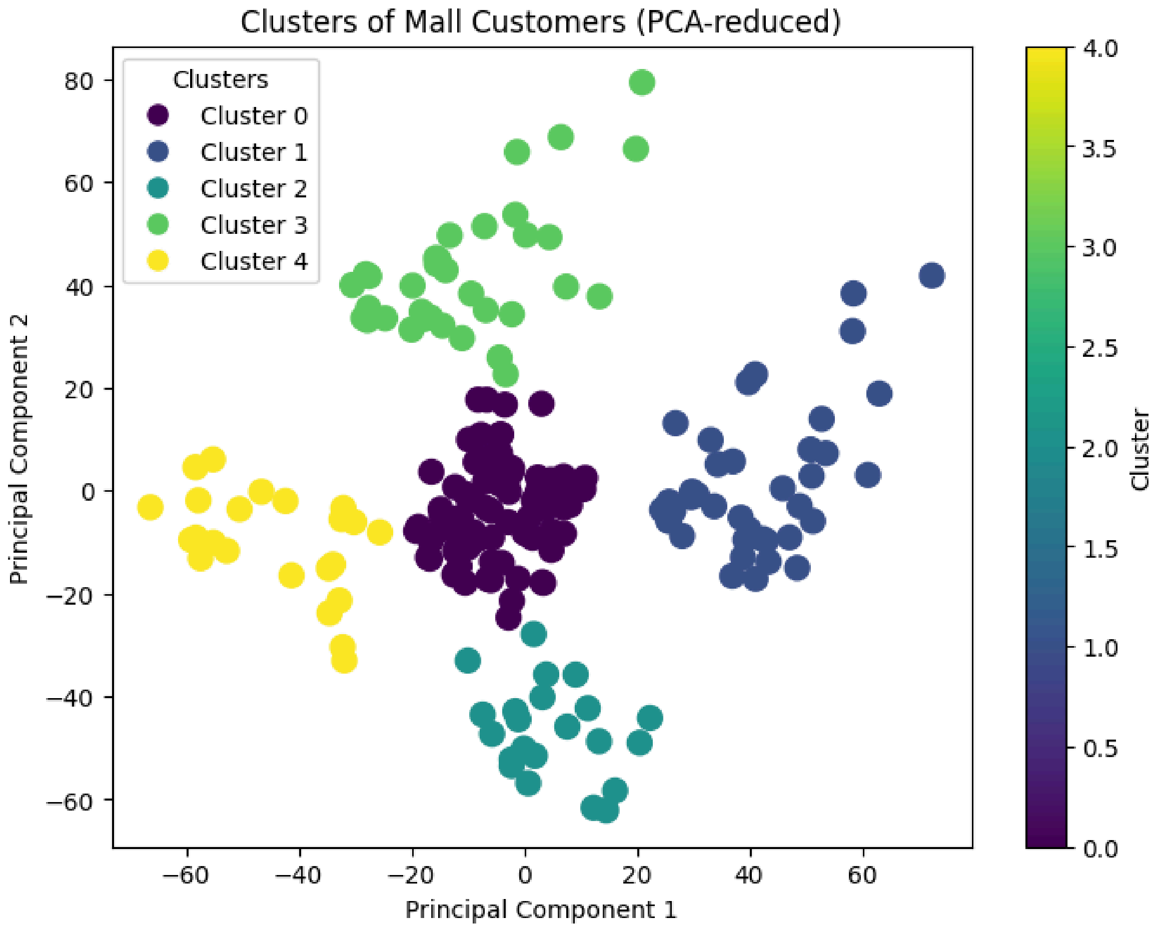


In [19]:
```
mall['Gender'] = mall['Gender'].map({'Male': 1, 'Female': 0})
```

In [20]:
```
pca = PCA(n_components=2)
mall_pca = pca.fit_transform(mall)

# Apply K-means clustering
kmeans = KMeans(n_clusters=5, random_state=42)
clusters = kmeans.fit_predict(mall_pca)

# Add the cluster results to the DataFrame
mall['cluster'] = clusters

# Plotting the clusters with PCA
plt.figure(figsize=(8, 6))
scatter = plt.scatter(mall_pca[:, 0], mall_pca[:, 1], c=clusters, cmap='viridis'

# Create a legend
handles = [plt.Line2D([0], [0], marker='o', color='w', markerfacecolor=scatter.c
labels = [f'Cluster {i}' for i in range(5)]
plt.legend(handles=handles, labels=labels, title='Clusters')

plt.title('Clusters of Mall Customers (PCA-reduced)')
plt.xlabel('Principal Component 1')
```

```
plt.ylabel('Principal Component 2')
plt.colorbar(label='Cluster')
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:1416: FutureWa
rning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set th
e value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
```



In [21]:
```
mall['cluster'].value_counts()
```

Out[21]:
```
cluster
0    82
1    39
3    34
4    23
2    22
Name: count, dtype: int64
```

In [ ]: