In [1]:
```
from IPython.display import HTML
HTML('''
    <style> body {font-family: "Roboto Condensed Light", "Roboto Condensed";} h2 {padding:
    content: "@"; font-family:"Wingdings"; font-style:regular; margin-right: 4px;} .text_c
''')
```

Out[1]:

In [2]:
```
# We understand that we should keep a copy of original data while cleaning,
# but for a clear view, we only keep final version of cleaned data
```

Data Cleaning

In [3]:
```
# CLEANING PROCESS
# all data are limited to
#       year 2019: pre-covid
#       year 2020: covid
#       year 2021: post-covid
# data format is kept in monthly order
# we always keep 2 columns 'Month' and 'Year'
```

In [4]:
```
# AFTER CLEANING
# each final dataset is convert to 36 rows (not including headers),
# from 2019 to 2021 with strictly 12 months per year.
```

In [3]:
```
import pandas as pd
import numpy as np
import calendar

international_student = pd.read_csv("instu_R1.csv")
transport_usage = pd.read_csv("transport_R2.csv")
employment = pd.read_csv("employment_R3.csv")
passenger = pd.read_csv("passenger_R4.csv")
```

Data 1 : Enrolment of international students

In [6]:
```
# Monthly international students' enrolments & commencements
```

In [2]:
```
# Replace headers with first row
new_header = international_student.iloc[0]
international_student = international_student[1:]
international_student.columns = new_header
# Rename headers
international_student.columns = ['Year','Month','State','Higher Education Enrolments','VET
                                 'Schools Enrolments','ELICOS Enrolments','Non-award Enrolr
                                 'Higher Education Commencements','VET Commencements','Scho
                                 'ELICOS Commencements','Non-award Commencements']
# Clear all year execept for Jan 19 to Dec 21
international_student = international_student[(international_student["Year"] == "2021") |
# Clear all states except "NSW"
international_student = international_student[(international_student["State"] == "NSW")]
```

In [3]:
```
international_student.head(3)
```

Out[3]:

	Year	Month	State	Higher Education Enrolments	VET Enrolments	Schools Enrolments	ELICOS Enrolments	Non-award Enrolments	Higher Education Commencements	Commenc
1	2019	Jan	NSW	98,257	59,377	4,596	19,714	7,580	1,762	
10	2019	Feb	NSW	120,224	66,453	4,690	23,231	11,711	23,729	
19	2019	Mar	NSW	127,674	68,510	4,699	26,951	12,724	31,179	

Data 2: Usage of public transport

In [9]:
```
# Monthly trips counts
```

In [10]:
```
# Restructure data
transport_usage = transport_usage.pivot_table(index='Year_Month', columns='Travel_Mode', v
# Delete last row ('total row')
transport_usage = transport_usage[:-1]
# Ensure all empty value are in the same format of nan
transport_usage = transport_usage.replace(' ', np.nan)
# 34 nan val exists
```

In [11]:
```
# Take 'Year_Month' column off 'Index'
transport_usage = transport_usage.rename_axis('Year_Month').reset_index()
# Split into 2 new columns: Year and Month
date = transport_usage['Year_Month'].str.split("-", expand=True,)
# Add new columns to data set
transport_usage = transport_usage.assign(Year=pd.DataFrame(date[0]))
transport_usage = transport_usage.assign(Month=pd.DataFrame(date[1]))
# Delete the old Year-Month column
transport_usage = transport_usage.drop('Year_Month', axis=1)
# Rearrange columns
transport_usage = transport_usage[["Year","Month","Bus","Ferry","Metro","Train","All"]]
# Clear all year execept for Jan 19 to Dec 21
transport_usage = transport_usage[(transport_usage["Year"] == "2021") | (transport_usage['
# Convert int to month
transport_usage.Month = transport_usage['Month'].apply(lambda x: calendar.month_abbr[int(x
```

In [12]:
```
transport_usage.head(3)
```

Out[12]:

Travel_Mode	Year	Month	Bus	Ferry	Metro	Train	All
30	2019	Jan	22040138.0	1619996.0	NaN	29925564.0	54210931.0
31	2019	Feb	25713814.0	1266715.0	NaN	32218764.0	60087643.0
32	2019	Mar	28742223.0	1300757.0	NaN	36530266.0	67583312.0

Data 3: Employment

In [13]:
```
# Unemployment rate and hours worked
```

In [14]:
```
# Delete last 2 'info' rows
employment = employment[:-2]
```

```
# Split 'Date' into 2 columns contain 'Year' and 'Month'
date = employment['Date'].str.split("-", expand=True,)
# Add 'Year' "Month" to data set
employment = employment.assign(Year=pd.DataFrame(date[1]))
employment = employment.assign(Month=pd.DataFrame(date[0]))
# Remove old column 'Date'
employment = employment.drop('Date', axis=1)
# Rearrange column
# list(a) then copy the output
employment = employment[['Year','Month','Unemployment rate(%)','Underemployment rate(%)',
                         "Employed people ('000)",'Hours worked (m)','Hours worked Yearly c
                         'Underemployment Males (%)','Underemployment Females (%)']]
# Clear all year execept for Jan 19 to Dec 21
employment = employment[(employment["Year"] == "19")
                        |(employment["Year"] == "20")
                        | (employment["Year"] == "21")]
employment['Year'] = employment['Year'].replace(['19', '20', '21'], ['2019', '2020', '2021
```

In [15]:
```
employment.head(3)
```

Out[15]:

	Year	Month	Unemployment rate(%)	Underemployment rate(%)	Employed people ('000)	Hours worked (m)	Hours worked Yearly change (%)	Underemployment Males (%)	Underemploy Femal
78	2019	Jan	5.1	8.1	12,747.20	1,762	3.6	6.2	
79	2019	Feb	5.0	8.1	12,747.30	1,764	2.3	6.3	
80	2019	Mar	5.1	8.3	12,780.70	1,779	3.0	6.5	

Data 4: Passenger Air Movement

In [16]:
```
# Monthly passenger movement at 20 major Australian airports
```

In [17]:
```
# Clear all airports outside NSW
passenger = passenger[(passenger["AIRPORT"] == "SYDNEY")]
# Clear all year execept for Jan 19 to Dec 21
passenger = passenger[(passenger["Year"] == 2019) | (passenger["Year"] == 2020) | (passeng
# Ensure all empty columns are in the same nan format
passenger = passenger.replace(' ', np.nan)
# Rearrange columns
passenger = passenger[['Year','Month','AIRPORT',
        'Dom_Pax_In','Dom_Pax_Out','Dom_Pax_Total',
        'Int_Pax_In','Int_Pax_Out','Int_Pax_Total',
        'Pax_In','Pax_Out','Pax_Total']]
passenger.Month = passenger['Month'].apply(lambda x: calendar.month_abbr[int(x)])
```

In [18]:
```
passenger.head(3)
```

Out[18]:

	Year	Month	AIRPORT	Dom_Pax_In	Dom_Pax_Out	Dom_Pax_Total	Int_Pax_In	Int_Pax_Out	Int_Pax_Total	
9084	2019	Jan	SYDNEY	1151296	1138031	2289327	887489	768912	1656401	2
9085	2019	Feb	SYDNEY	1041047	1041948	2082995	707952	612960	1320912	1
9086	2019	Mar	SYDNEY	1168035	1163665	2331700	656438	672111	1328549	1

In [19]:
```
# Export data frame to csv without index column
international_student.to_csv("instu_C1.csv", index = False)
transport_usage.to_csv("transport_C2.csv", index = False)
employment.to_csv("employment_C3.csv", index = False)
passenger.to_csv("passenger_C4.csv", index = False)
```

Visualisation

In [ ]:
```
# I want to emphasize the change in 2020, when covid starts
```

In [27]:
```
from matplotlib import pyplot as plt

international_student = pd.read_csv("instu_C1.csv", thousands=',')
transport_usage = pd.read_csv("transport_C2.csv")
employment = pd.read_csv("employment_C3.csv", thousands=',')
passenger = pd.read_csv("passenger_C4.csv")
```

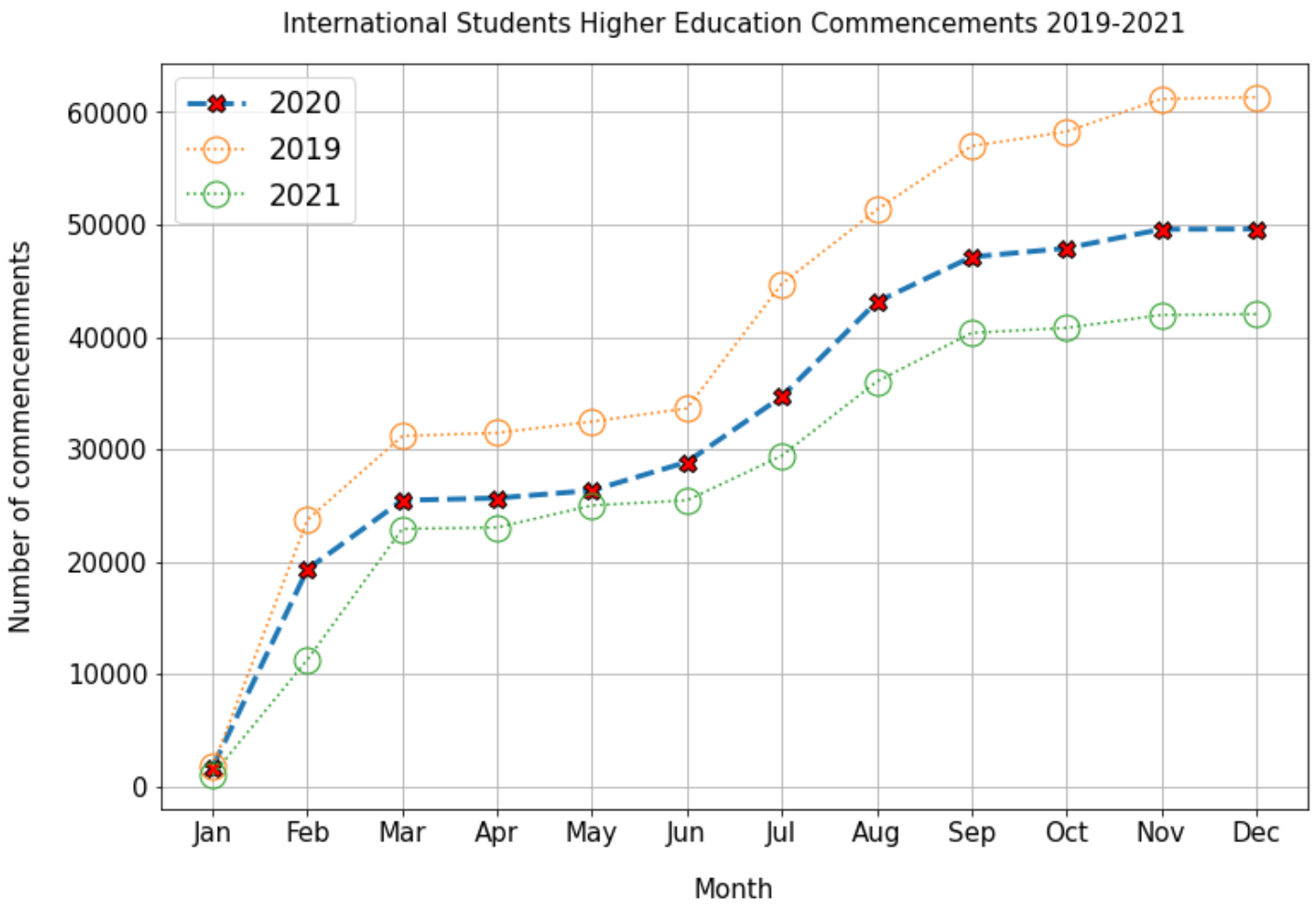
D1: International Students

In [22]:
```
# Commencement of International Students from 2019 to 2021
# in Higher Education sector
is19 = international_student[international_student['Year']==2019]
is20 = international_student[international_student['Year']==2020]
is21 = international_student[international_student['Year']==2021]
x = is19['Month']
y19 = is19['Higher Education Commencements']
y20 = is20['Higher Education Commencements']
y21 = is21['Higher Education Commencements']
```

In [23]:
```
# Line graph (FIG 1.1)
plt.figure(figsize=(12,8))

plt.plot(x, y20, ls="--", lw=3, marker="X", markersize=10,
         markerfacecolor="red", markeredgecolor="black",label="2020")
plt.plot(x, y19, ls=":", marker="o", markersize=15,
         markerfacecolor="None", label="2019")
plt.plot(x, y21, ls=":", marker="o", markersize=15,
         markerfacecolor="None", label="2021")

plt.title('International Students Higher Education Commencements 2019-2021'
          , fontsize=15, pad=18)
plt.grid()
plt.xlabel('Month', fontsize=15, labelpad=18)
plt.ylabel('Number of commencemments', fontsize=15, labelpad=18)
plt.xticks(fontsize=15)
plt.yticks(fontsize=15)
plt.legend(fontsize=17)
plt.show()
# plt.savefig('line.png')
```



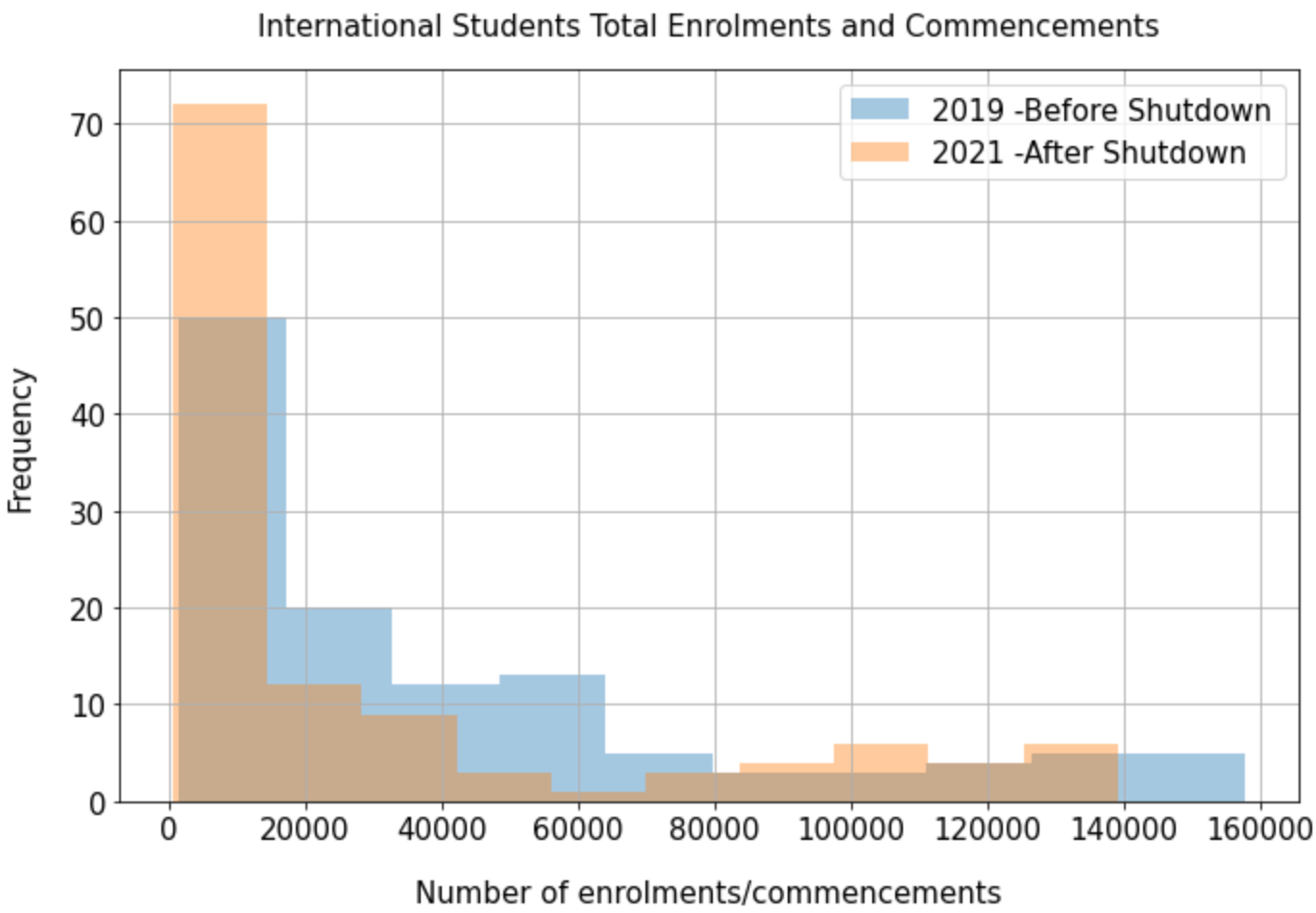
In [24]:

```
# Total Enrolments and Commencements of International Students
# Each year from 2019 to 2021
x19 = pd.melt(is19,id_vars=['Year','Month','State'])['value']
is21 = pd.melt(is21,id_vars=['Year','Month','State'])['value']
```

In [25]:

```
# Histogram (FIG 1.2)
plt.figure(figsize=(11,7))
plt.hist(x19, alpha=0.4, label='2019 -Before Shutdown')
plt.hist(x21, alpha=0.4, label='2021 -After Shutdown')

plt.title('International Students Total Enrolments and Commencements'
          ,fontsize=15, pad=18)
plt.grid()
plt.xlabel('Number of enrolments/commencements', fontsize=15, labelpad=18)
plt.ylabel('Frequency', fontsize=15, labelpad=18)
plt.xticks(fontsize=15)
plt.yticks(fontsize=15)
plt.legend(fontsize=15)
plt.show()
# plt.savefig('hist.png')
```

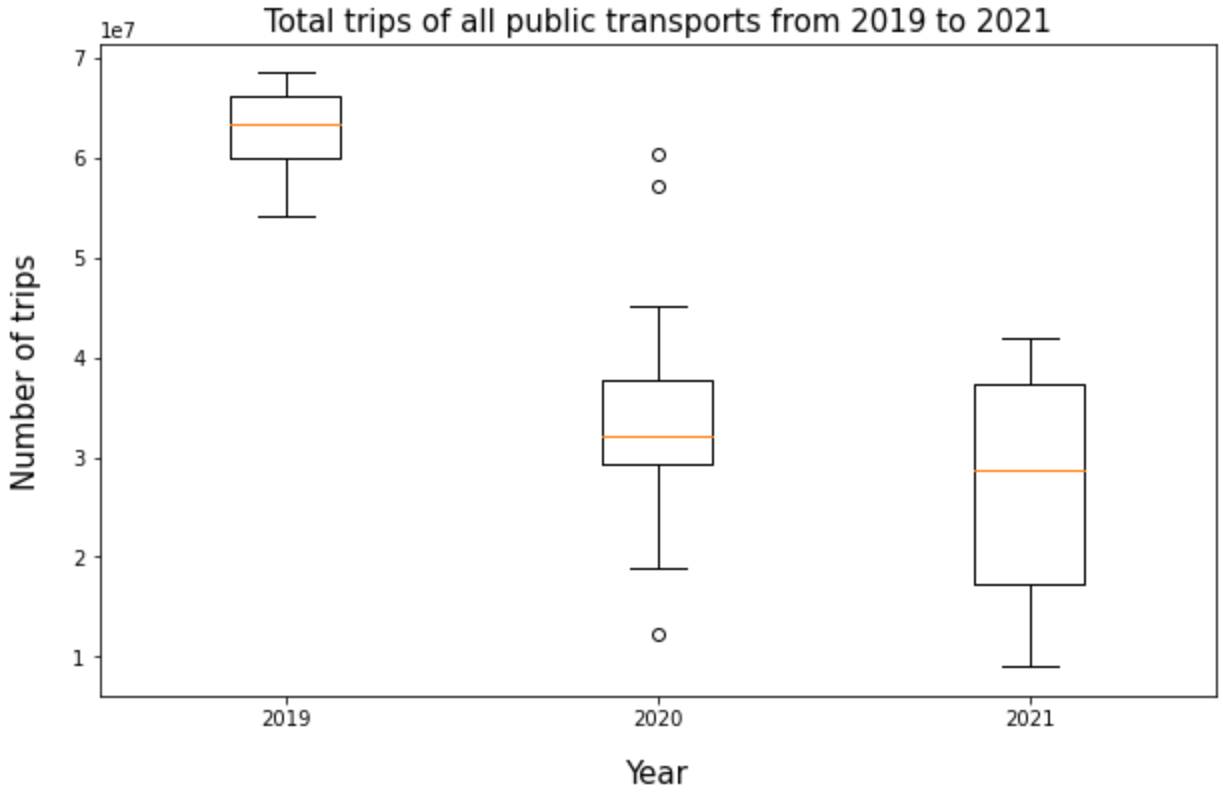


D2: Public transport usage

In [33]:

```
# Total trips of all public transports from 2019 to 2021
# Boxplot (FIG 2.1)
tp19 = transport_usage[transport_usage['Year']==2019]['All']
tp20 = transport_usage[transport_usage['Year']==2020]['All']
tp21 = transport_usage[transport_usage['Year']==2021]['All']

plt.figure(figsize=(10,6))
plt.title('Total trips of all public transports from 2019 to 2021', fontsize=15)
plt.boxplot([tp19, tp20, tp21], labels = ['2019', '2020', '2021'])
plt.xlabel("Year", fontsize=15, labelpad=15)
plt.ylabel("Number of trips", fontsize=15, labelpad=15)
plt.show()
```

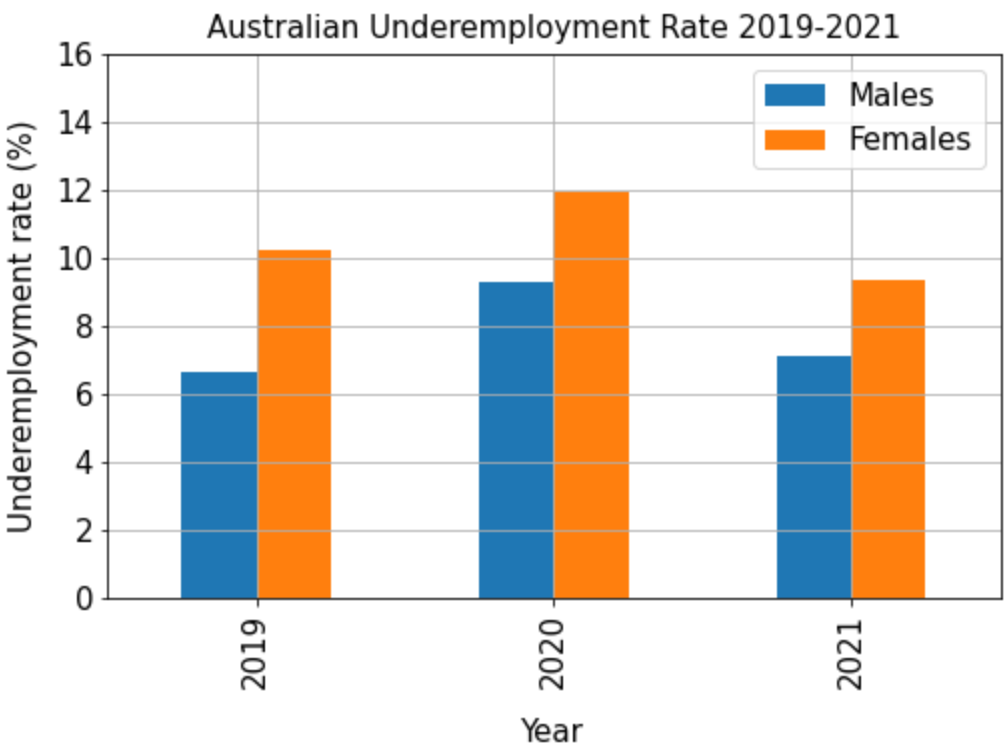


D3: Employment

In [37]:

```
# Bar chart (FIG 3.1)
employment = employment.groupby('Year').mean()
employment = employment.rename_axis('Year').reset_index()

employment.plot.bar(x='Year', y=['Underemployment Males (%)', 'Underemployment Females (%)
            label=['Males', 'Females'], figsize = (8, 5))
plt.title('Australian Underemployment Rate 2019-2021', fontsize=15, pad=8)
plt.grid()
plt.xlabel('Year', fontsize=15, labelpad=15)
plt.ylabel('Underemployment rate (%)', fontsize=15, labelpad=8)
plt.ylim(0, 16)
plt.xticks(fontsize=15)
plt.yticks(fontsize=15)
plt.legend(fontsize=15)
plt.show()
```



D4: Passenger air movement

In [39]:

```
# Bar Chart (FIG 4.1)
passenger = passenger.groupby('Year').sum()
passenger = passenger.rename_axis('Year').reset_index()

passenger.plot.bar(x='Year',y=['Dom_Pax_In', 'Dom_Pax_Out', 'Int_Pax_In', 'Int_Pax_Out'],
        title='Total number of passengers going in and going out, international and domest
        xlabel='Year', ylabel='Number of passengers movement')
# Rotates X-Axis Ticks by 360-degrees
plt.xticks(rotation=360)
plt.grid()
```