```
import networkx as nx
def Create_nodes():
  import networkx as nx
  seed=1000           # seed the graph for reproducibility, you should be doing this
  G= nx.gnp_random_graph (10, .3, seed=seed )       # here we create a random binomial gra
  nx.is_connected(G)      # check whether which has at least one path between each pair of
  import random
  for (u, v) in G.edges():
    eweights=G.edges[u,v]['weight'] = random.randint(1,20)    # assign random weights to e
  import matplotlib.pyplot as plt
  links = [(u, v) for (u, v, d) in G.edges(data=True)]
  pos = nx.nx_pydot.graphviz_layout(G)
  nx.draw_networkx_nodes(G, pos, node_size=1200, node_color='lightblue', linewidths=0.25)
  nx.draw_networkx_edges(G, pos, edgelist=links, width=4)
  # node labels
  nx.draw_networkx_labels(G, pos, font_size=20, font_family="sans-serif")
  # edge weight labels
  edge_labels = nx.get_edge_attributes(G, "weight")
  nx.draw_networkx_edge_labels(G, pos, edge_labels)
  plt.title("Created Nodes and edges")
  plt.show()
  return G,edge_labels
```

Function to find p Random normal distribution

```
def p():
  import numpy as np
  return np.random.normal(0, 0.25)
```

Function to Update weights

```
def update_Weights(W,P,b):
  for i in W:
    W[i] = b * W[i] * P
  return W
```

Function to find the Overall Load Factor

```
def dict_diff(W1, W2):
  a=[]
  for i in W1:
    a.append(W2[i]-W1[i])
  return a
```

Function to find the Find the nodes travelled through , Total time taken for the Journey

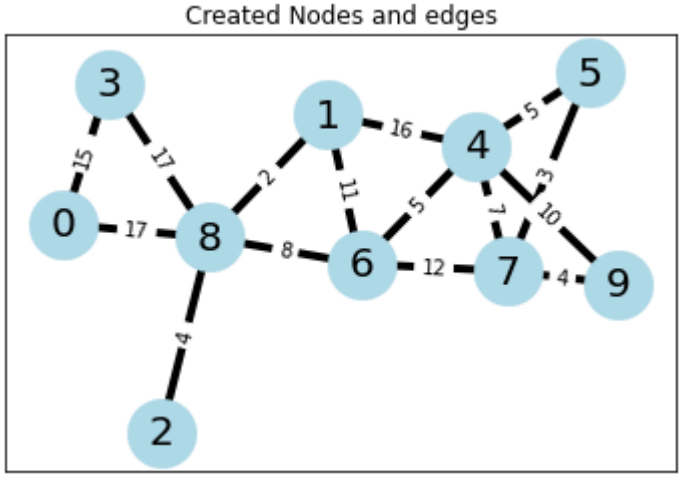
```
def load_and_nodes(G,W,S,D,T):
```

```
base_level = {8:1.0 , 9:0.95, 10:0.9 , 11:0.9 , 12:0.9, 13:0.9, 14:0.95, 15:0.95, 16:0.9
              17:1.0, 18:1.0, 19:0.85, 20:0.7, 21:0.6, 22:0.45, 23:0.3, 0:0.1, 1:0.1,
              2:0.1, 3:0.15, 4:0.25, 5:0.3, 6:0.65, 7:0.85}
import networkx as nx
l = nx.astar_path(G, S, D, heuristic=None, weight='weight')
lf = 0.0
if (S >l[1]):
  a=l[1]
  b=S
else :
  b=l[1]
  a=S
Time_taken = W[a,b]
olf = 0.0
P = p() + 1
nodes=[]
while(len(l) != 1):
  # condition to check the change in time for every 15 mins and checking if Overall Load
  if(lf <(Time_taken + 15) and olf < 5.0):
    if (S >l[1]):
      a=l[1]
      b=S
    else:
      b=l[1]
      a=S
    # Calculating the load Factor
    lf =  W[(a, b)] * base_level[int(T+(Time_taken/60))] * P
    Time_taken += lf
    S = l[1]
    # Storing the nodes travelled through
    nodes.append(l[0])
    l.pop(0)
  else:
    P = p() + 1
    if (S > l[1]):
      a=l[1]
      b=S
    else :
      b=l[1]
      a=S
    lf =  W[(a, b)] * base_level[int(T+(Time_taken/60))] * P
    Time_taken += lf
    S = l[1]
    # Updating the weights for new P values
    updated_W = update_Weights(W,P,base_level[int(T+(Time_taken/60))])
    a = dict_diff(W, updated_W)
    # Calculating the Overall Load Factor
    olf = sum(a)/len(a)
    W = updated_W
    # Storing the nodes travelled through
    nodes.append(l[0])
    # Calculating the shortest path
    l = nx.astar_path(G, S, D, heuristic=None, weight='weight')
nodes.append(l[0])
return T,nodes, Time_taken
```

```
# Finding the sum of time taken by all the vechiles
def Total_sumofVechiles(C):
  return sum(C)


# Dropping the vechiles once the journey is completed
def remove_completedVechiles(df):
  df = df.sort_values(by=['Start Time (24hrs)'])
  for i in range(0,9):
    df = df.loc[9:9]
  return df


if __name__ == "__main__":
  import random
  from datetime import datetime
  import pandas as pd
  G,W = Create_nodes()
  lst = [1, 2, 3, 4, 5, 6, 7, 8, 9]
  A,B,C=[],[],[]
  # Initiating 10 Vechiles to travel at different times.
  for i in range(10):
    S = random.randint(1,len(lst))
    D = random.randint(1,len(lst))
    while S == D:
      D = random.randint(1,len(lst))
    # Retriving the data of each vechile
    a,b,c = load_and_nodes(G,W,S,D,random.randint(0,20))
    A.append(datetime.strptime(str(a), '%H').time())
    B.append(b)
    C.append(c)
  data = {
  "Nodes Travelled through": B,
  "Total Time Taken (in mins)": C,
  "Start Time (24hrs)" : A
  }
  df = pd.DataFrame(data=data)
  print(df.head(10))
  remove_completedVechiles(df)
  print("Total time taken for all the Vechiles (in mins) : " + str(Total_sumofVechiles(C))
```



	Nodes Travelled through	Total Time Taken (in mins)	Start Time (24hrs)
0	[4, 5]	10.655536	17:00:00
1	[8, 1]	3.540134	12:00:00
2	[9, 4, 6, 8]	36.898490	14:00:00
3	[9, 4, 6, 8, 1]	26.701726	06:00:00
4	[8, 6, 4]	22.850876	14:00:00
5	[6, 4, 9]	8.110609	04:00:00
6	[9, 4, 6, 8]	12.392708	03:00:00
7	[2, 8, 6, 4, 9]	31.375036	17:00:00
8	[5, 7]	3.224886	00:00:00
9	[7, 6, 8, 2]	13.228915	02:00:00

Total time taken for all the Vechiles (in mins) : 168.97891630873139