Manisa Celal Bayar University – Department of Computer Engineering
CSE 3237 Parallel Programming – Midterm Exam

Name and Surname	
Student Id	
Signature	

Question	1	2	3	4	Total
Score					

Questions

Q1 (25 Points) The Python program given below fetches the from a URL which returns a dictionary including the prime numbers below an integer n. Please fill the empty area with the definition of **scheduling** function/coroutine to send multiple requests to this URL asynchronously.

```
import asyncio
import aiohttp

async def get_primes_below(number: int, session: aiohttp.ClientSession) -> list:
    print(f"Getting primes below {number}")
    headers = {
        "User-Agent": "Mozilla/5.0 (Macintosh; Intel Mac OS X 12_6) "
        "AppleWebKit/537.36 (KHTML, like Gecko) "
        "Chrome/106.0.0.0 Safari/537.36"
    }
    url = f"https://www.canbula.com/prime/{number}"
    async with session.get(url, headers=headers, ssl=None) as response:
        primes = (await response.json())["primes"]
    print(f"Got primes below {number}: {primes}")
    return primes

async def scheduling(numbers: list):
    session = aiohttp.ClientSession()
    objects = [get_primes_below(n, session) for n in numbers]
    await asyncio.gather(*objects)
    await session.close()

if __name__ == "__main__":
    asyncio.run(scheduling([50, 10, 30, 40, 20]))
```

Q2 (25 Points) Write a Python **context manager** with the name ThreadGenerator which generates threads from a list of functions as given in the code below. ThreadGenerator must satisfy the following requirements:

- Threads must be started when the `with` statement is entered.
- The code inside the `with` block must be executed concurrently with the threads.
- Threads must be joined when the `with` statement is exited.

```
import threading
import time

class ThreadGenerator:
    def __init__(self, functions: list = []):
        self.functions: list = functions
        self.threads: list = []

    def __enter__(self):
        for function in self.functions:
            thread = \
              threading.Thread(target=function)
            thread.start()
            self.threads.append(thread)
        return self

    def __exit__(self, e_type, e_val, e_tb):
        for thread in self.threads:
            thread.join()




def main():
    def f1():
        time.sleep(1)
        print("f1")

    def f2():
        time.sleep(5)
        print("f2")

    def f3():
        time.sleep(3)
        print("f3")

    with ThreadGenerator([f1, f2, f3]):
        print("Hello")

if __name__ == "__main__":
    main()
```

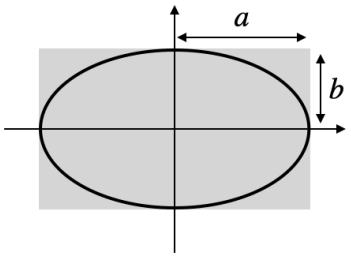
Q3 (25 Points) The Wallet class given in the code below will be used in many threads. Modify or rewrite this class to be sure that no **race condition** occurs.

```
import threading

class Wallet:
    def __init__(self):
        self.balance = 0

    def deposit(self, amount):
        self.balance += amount

    def withdraw(self, amount):
        self.balance -= amount
```

```
import threading

class Wallet:
    def __init__(self):
        self.balance = 0
        self.lock = threading.Lock()

    def deposit(self, amount):
        with self.lock:
            self.balance += amount

    def withdraw(self, amount):
        with self.lock:
            self.balance -= amount
```

Q4 (25 Points) Write a Python program to estimate the area of an ellipse using the Monte Carlo method. Please make your code should be using **multiple threads** but not suffering from **GIL**.

```
import random
import numpy as np
import threading
from numba import jit

class AtomicThread(threading.Thread):
    def __init__(self, n, a, b):
        super().__init__()
        self.n: int = n
        self.a: float = a
        self.b: float = b
        self.count: int = 0

    @staticmethod
    @jit(nopython=True, nogil=True)
    def generate(n, a, b):
        count = 0
        for _ in range(n):
            x = random.uniform(0, a)
            y = random.uniform(0, b)
            if (x**2 / a**2 + y**2 / b**2) <= 1:
                count += 1
        return count

    def run(self) -> None:
        self.count = self.generate(self.n, self.a, self.b)

def estimate_area(n, m, a, b):
    count = 0
    threads = []
    for _ in range(m):
        threads.append(AtomicThread(n, a, b))
    for thread in threads:
        thread.start()
    for thread in threads:
        thread.join()
    for thread in threads:
        count += thread.count
    return (count / (n * m)) * (4 * a * b)

def main():
    a, b = 2, 3
    estimated_area, calculated_area = estimate_area(100000, 8, a, b), np.pi * a * b
    print(f"Estimated area: {estimated_area} | Calculated area: {calculated_area}")
    print(f"Error: {abs(estimated_area - calculated_area)}")

if __name__ == "__main__":
    main()
```



Points in the ellipse follows:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

Area of an ellipse is given as:

$$\pi \cdot a \cdot b$$

	QUESTIONS VS PÇB MATRIX																											
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Q1	✓	✓					✓	✓																				
Q2	✓	✓						✓																				
Q3	✓	✓					✓	✓																				
Q4	✓	✓																										

You have 90 minutes, gl hf.

Assoc. Prof. Dr. Bora Canbula