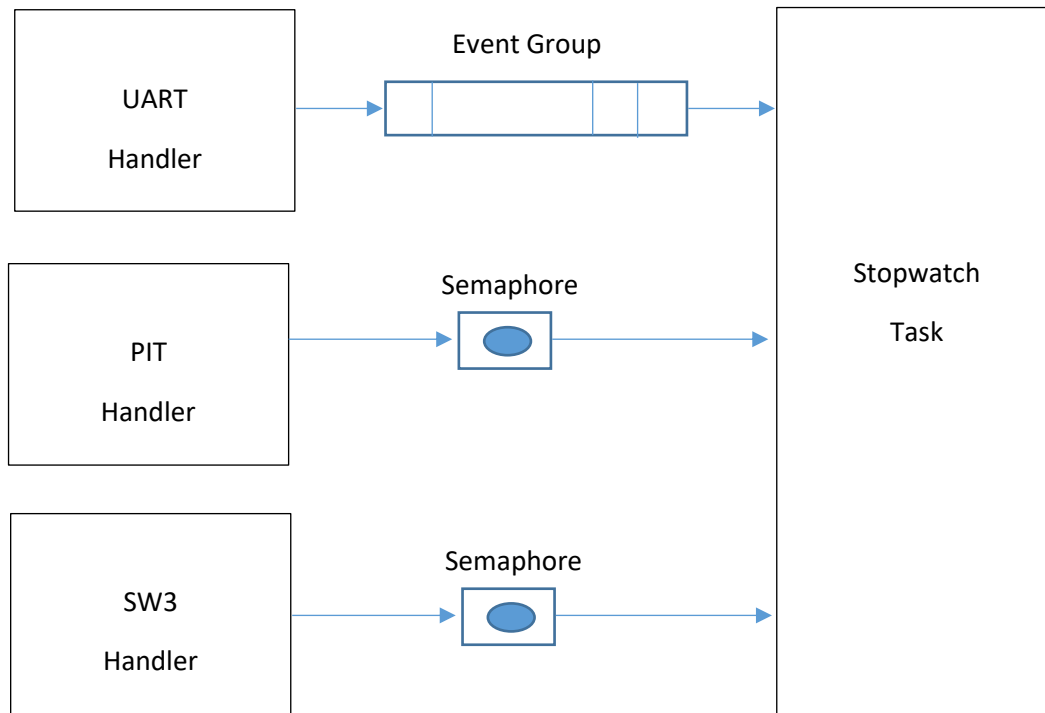**Exam Duration: 1 hour 40 minutes**

Write a C program to implement a stopwatch that is accurate to 100ms. Your C program should contain 3 interrupt handlers and 1 task.

COM4

```
Starting Stopwatch Task
Press g to start stopwatch

Stopwatch started. Press l for Lap Time, Press s to stop.
Lap: 1  Lap Time: 3.900 seconds Total Time: 3.900 seconds
Lap: 2  Lap Time: 3.600 seconds Total Time: 7.500 seconds
Lap: 3  Lap Time: 6.300 seconds Total Time: 13.800 seconds
Stopping Stopwatch
Total Time: 13.800 seconds       Fastest Lap: 3.600 seconds      Average Lap: 4.600 seconds
Press g to start stopwatch

Stopwatch started. Press l for Lap Time, Press s to stop.
Lap: 1  Lap Time: 5.100 seconds Total Time: 5.100 seconds
Lap: 2  Lap Time: 6.400 seconds Total Time: 11.500 seconds
Stopwatch Reset

Type g to start stopwatch
```

The UART is configured in interrupt mode. The UART interrupt handler will synchronise with the stopwatch task using an Event Group with 3 bits. The user types the character 'g' into the serial terminal to start the stopwatch. The user types the character 'l' to signify that a lap is complete. The user types 's' when the timing session is complete. The UART interrupt handler will set an event group bit for each of these 3 characters typed – goBit, lapBit, stopBit.

The PIT timer is configured for a 100ms interrupt and is the time base of the system. The PIT handler synchronises with the stopwatch task by giving a semaphore every 100ms. The stopwatch task uses the semaphore to derive the 0.1 second accuracy.

An interrupt should be configured for the SW3 switch. Pressing SW3 will stop the stopwatch running and reset it. SW3 is connected to GPIO pin PTA4.

The stopwatch task provides the timing information to the user. The PIT semaphore is taken to provide the 100ms time base for the stopwatch. The SW3 semaphore is taken to reset the stopwatch. The task waits for the event group bits to be set. The goBit is used to start the stopwatch. The lapBit is used to signify that a lap has been completed. The task should print the lap time and the overall time. The stopBit signifies that the timing operation is complete and the total time, fastest lap time and the average lap time should be printed to the terminal.

Marking Scheme

SW3, PIT Interrupt Handlers   20%
UART Interrupt Handler   20%
Stopwatch Task   60%

Upload your C file along with screenshots of the 3 peripheral configurations to Learnonline.

Do not change the interrupt handler names when configuring the peripherals.