2005 Paper 10 Question 6

Operating System Foundations

(*a*) A device driver process carries out character I/O via a Universal Asynchronous Receiver/Transmitter (UART).

   (*i*) Why is hardware–software synchronisation needed? [1 mark]

   (*ii*) Describe polled operation. [2 marks]

   (*iii*) Describe interrupt-driven operation. [2 marks]

   (*iv*) Draw a state transition diagram for the device-driver process. Indicate the events that cause each transition and in each case explain the effect on the device driver's process descriptor and the operating system's scheduling queues. Assume interrupt-driven software. [7 marks]

(*b*) The device driver process fills/empties a buffer of fixed size in an I/O buffer area. A process carrying out application requests reads and writes data in variable-sized amounts from the buffer.

   (*i*) Why must mutually exclusive access to the buffer be enforced? [2 marks]

   (*ii*) Why is condition synchronisation needed? [2 marks]

   (*iii*) What is wrong with the following pseudocode fragment from the device-driver's specification, where:

- `buffer-lock` is a semaphore initialised to `1`,

- `space` is a semaphore initialised to the buffer size in bytes,

- `data` is a semaphore initialised to `0`?

```
on input:                         on output:
WAIT(buffer-lock);                WAIT(buffer-lock);
if buffer is full then WAIT(space);  if buffer is empty then WAIT(data);
write a character into the buffer;   read a character from the buffer;
SIGNAL(buffer-lock);              SIGNAL(buffer-lock);
```

[4 marks]