3 Computer Design (TMJ)

(*a*) (*i*) Describe the four classes in Flynn's taxonomy of computing systems. [4 marks]

(*ii*) Describe Amdahl's law and use it to calculate the maximum speedup achievable by running a program, P, on a multicore system, S, where 80% of P is parallel and S contains 16 cores. [4 marks]

(*b*) Consider the following pseudo-code that is run on a SIMD processor with 8 lanes, where `i` gives the lane number.

```
r1 = load X[i]
r2 = load Y[i]
if (i%2 == 0)
  if (i%8 == 0)
    r1 = r1 * 2
    r1 = r1 + r2
  endif
else
  r1 = r1 - r2
endif
store r1, X[i]
```

(*i*) Describe how the processor can support branch divergence between the different lanes. [4 marks]

(*ii*) With the aid of a diagram, show the utilisation of the SIMD lanes for each pseudo-code operation, hence calculate the code's efficiency (overall utilisation of the SIMD lanes). [6 marks]

(*iii*) What architectural technique do GPUs employ to allow them to perform useful work even though the loads from `X` and `Y` often cause stalls? [2 marks]