Coursework 2026
Deadline: 17/03/2026, 11am.
Please upload a PDF version of your Jupyter Notebook.

1. Estimate the following integral using Monte Carlo simulation by sampling 5,000 points. Give a 95%
   confidence interval for the value of I.

$$I = \int_{\sqrt{2}}^{\sqrt{\pi}} \sin(x^2)dx$$

[35%]

2. An certain internet protocol (Protocol 1) can be modelled as an $D/E_4/3/20/FIFO$ queue, where sig-
   nals arrive exactly every 2 seconds, there are three parallel servers to process the signals, and processing
   times can be modelled as an Erlang distribution with parameters $n = 4$ and $\lambda = \frac{7}{10}$. Only 17 waiting
   signals can be held in the computers' memory at any point.

   An alternative internet protocol (Protocol 2) can be modelled in a similar way, as a $D/G/3/20/PQ$
   queue, where there are now two different types of signal being processed by the same three parallel
   servers: Signals of type A arrive exactly every 2.5 seconds, and the time to process them can be
   modelled as an Exponential distribution with rate $\frac{1}{4}$ per second. Signals of type B arrive exactly every
   4 seconds, and the time to process them can be modelled as a Uniform distribution between 3 and 5
   seconds. Signals of type B have priority over signals of type A.

   Both protocols operate 24 hours a day, 7 days a week.

   For each scenario, use discrete-event simulation to find the following measures of interest:

   (a) W_q the average amount of time signals spend in the queue.

   (b) W the average amount of time signals spend in the system.

   (c) L the average amount of signals in the system.

   (d) L_q the average amount of signals in the queue.

   (e) The probability of an arriving signal being turned away as the queue is full.

[65%]