SESA6085 – Advanced Aerospace Engineering Management

Coursework Assignment (25/26)

Due date: 23:00, 27th November

Please answer the following questions. Solutions should be submitted along with your working and any additional files (Excel workbooks, Matlab/python scripts etc.) used as part of your calculations to e-assignments before the deadline.

Marks for each question are given in brackets. This assignment is worth 20% of your final overall module grade.

Q1 The attached spreadsheet contains data relating to the failure of an arbitrary component. Use this data to answer the following questions assuming that:

- The data provided represents failure times in hours
- The component has two different failure modes
  - One mode follows a normal distribution
  - The second mode follows a log-normal distribution
- The failure times are censored
  - T_R – denotes the right-censored time
  - C_R – denotes the amount of right-censored data
  - T_L – denotes the left-censored time
  - C_L – denotes the amount of left-censored data
- Assume that the possible bounds for the normal distribution parameters are
  - $20 \leq \mu \leq 60$
  - $0.5 \leq \sigma \leq 10$
- Assume that the possible bounds for the log-normal distribution parameters are
  - $1 \leq \mu \leq 5$
  - $0.5 \leq \sigma \leq 5$

N.B. use the data associated with your student number and only this data. If you cannot find your student number contact the module lead ASAP (djjt@soton.ac.uk).

(a) Use the data provided to estimate the parameters of this model. **(4 marks)**

(b) Calculate the probability that the system will fail after 35 hours. **(1 marks)**

Q2 As part of the development phase of a small satellite communications network, an assessment is made of the reliability of the network after a period of time. Figure 1 below provides a schematic indicating the potential flow of information between ground station 1 (G1) and ground station 2 (G2) via six satellites (S1-6). The arrows in this schematic represent a one-way flow of data between each ground station i.e. data can flow from S1 to S5 but not from S5 to S1.

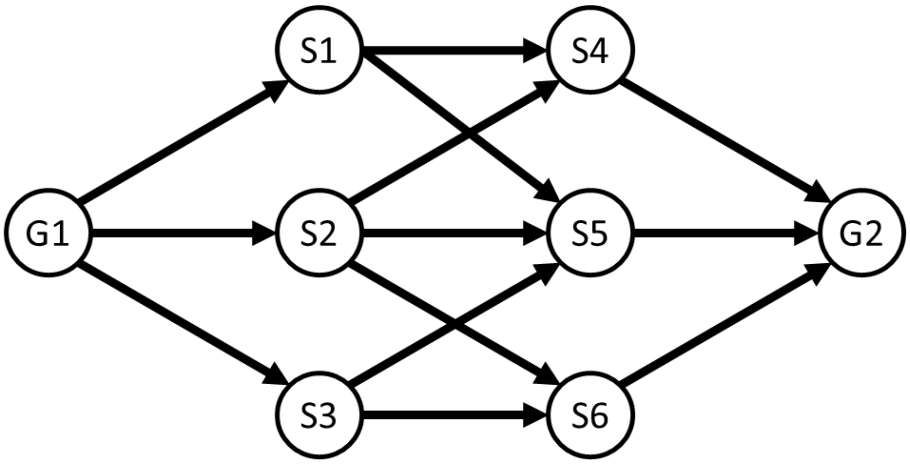

Figure 1 – Communications network schematic

(a) How many potential routes are there for data to pass from G1 to G2? List these routes. **(2 marks)**

Figure 2 presents the RBD of one of the satellites in the above communications network. Each component is assumed to be modelled as a 2-parameter Weibull distribution with the parameters for each sub-system presented in Table 1. The numbers in Figure 2 indicate any requirements for m/n redundancy, the solar array for example requires at least three of the four independent arrays installed on the satellite to be operational. For sub-systems with no m/n indicated it is assumed that only one of these sub-systems is present e.g. there is only one computer. Assume all PDFs are a function of time in years.

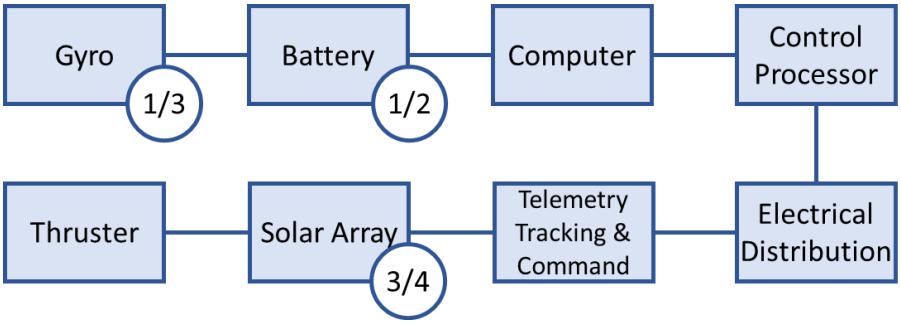

Figure 2 – Satellite system RBD

(b) Use the RBD presented in Figure 2 and the PDF parameters in Table 1 to calculate the reliability (to 4 d.p.) of a single satellite after 20 years. **(5 marks)**

(c) As a designer what satellite sub-systems would you target for improvement and why? **(3 marks)**

(d) Employ a Monte Carlo simulation with 500 iterations to calculate the probability that at 20 years it will still be possible to transmit a signal from G1 to G2. Assume that the ground stations have perfect reliability and that the ability of a single satellite to receive/transmit data is captured by the RBD in Figure 2. **(10 marks)**

Table 1 – Sub-system reliability information		
	β	η
Gyro	0.7	3800
Thruster	0.33	6,200
Control Processor	1.4	400
Computer	0.88	900
Battery	0.7	700
Electrical Distribution	0.5	1,600
Solar Array	0.4	150,000
Telemetry Tracking & Command	0.39	50,000

Total of 25 marks