To do: Make a submission

1. You are required to develop an Excel model to analyse non-repairable systems according to the Weibull distribution. You are provided with five podcasts guiding you through the model development process. The same examples as in chapter 3.7 in your notes are used during the podcasts. The podcasts also illustrate the use of the functions in your notes, so it will be useful to have your notes at hand (especially for the confidence interval calculations).

- **Note: You will be allowed to use your developed model during the test week (A1). The onus is therefore upon you to ensure you have a working model. If you don't, you will have to develop it from scratch during A1.**

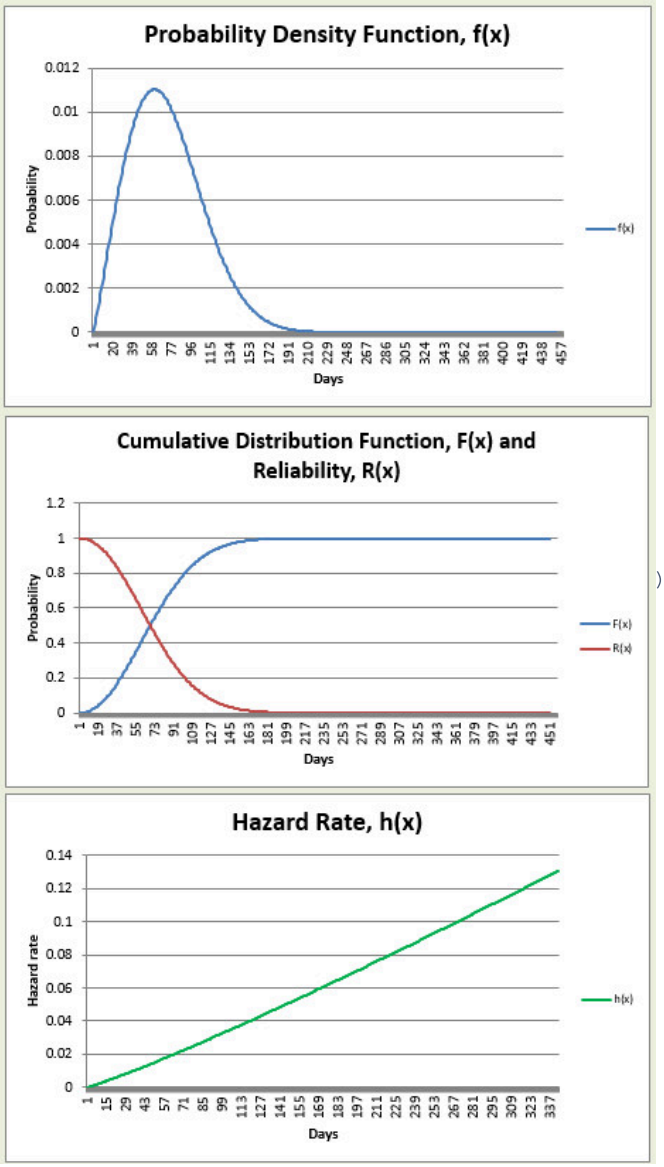
2. Refer to chapter 3.7 in your notes and use your model to answer the questions. Ensure your model produces the correct answers.

3. Assume the data below is random and that it is appropriate to utilise non-repairable systems theory to assess the failure characteristics of the system.

Obs.	X_i	C_i
1	49	1
2	52	1
3	101	1
4	45	1
5	30	0
6	29	1
7	81	1
8	86	0
9	28	1
10	107	0
11	64	1
12	66	1
13	116	0
14	49	1
15	80	1
16	75	0
17	33	1
18	15	1
19	79	1
20	92	1

(a) Fit a Weibull distribution to the data and use the maximum likelihood method to calculate *beta* and *eta*. (Ans: *eta* = 80.73670386; *B* = 2.114037517, with starting values of 0.1 for both *eta* and *B*)

(b) Plot *f(x)*, *F(x)*, *R(x)* and *h(x)*. Use increments of "one" to develop these graphs.

(Ans: 

)

(c) Assume the system is currently in operation and x = 20 days. What do you expect the residual life to be if a preventive maintenance policy is in place at X_p = 60 days? Provide your answer within 80% confidence bands. (Ans: Residual life = 22.59705651; lower confidence limit = 5 days; higher confidence limit = 36 days)

(d) Assume the system is currently in operation and x = 30 days. What do you expect the residual life to be if no preventive maintenance action is taken? Provide your answer within 90% confidence bands. (Ans: Residual life = 48.46003761; lower confidence limit = 5 days; higher confidence limit = 107 days)

4. The data in the table below was compiled from the failure history of a pump. Use the data to answer the questions below. For interpretation and calculation purposes take note that the inter-arrival times are in days.

#	X_i (dae/days)	T_i (dae/days)	C_i
1	150	150	1
2	28	178	1
3	161	339	0
4	147	486	1
5	176	662	0
6	113	775	1
7	117	892	1
8	69	961	1
9	80	1041	0
10	41	1082	1
11	66	1148	1
12	138	1286	0
13	11	1297	1
14	138	1435	1
15	23	1458	1
16	75	1533	0
17	177	1710	1
18	161	1871	1

(a) Is there a trend in the inter-arrival times to failure? Use Laplace's trend test to motivate your answer.

- Ans: 0.237771, non-commital

(b) Fit a Weibull distribution to the data set by maximizing the likelihood of the distribution. Write your values for beta, eta and the maximum likelihood down. Interpret the beta and eta values.

- Ans: B = 1.613487198; eta = 137.9400842; L = -75.9645985

(c) Previous records show that the cost of preventive replacement is C_p=1000 and that the cost of unexpected failure replacement is $Cf(x)$=800+30x, where x is continuous local time and the costs are measured in Rand (R). It is also known that it takes 2 hours to perform the preventive replacement and it takes 0.11x+2 hours to do an unexpected failure replacement. Calculate the optimal long term preventive replacement interval as well as the cost per day if preventive action is always taken at the calculated interval.

- Ans: CX_p=R24.71966/day; X_P=68 days

(d) When do you expect will the next failure occur if the current pump is brand new and if there is a preventive replacement policy in place as calculated in Question (c)? Assume that the preventive replacement policy is in place for Questions (e) as well.

- Ans: 40.68 days

(e) A trainee reliability engineer calculated the lower and higher confidence limits as 26 and 54 days, respectively. How much confidence do you have that the pump will fail within these limits?

- Ans: 50%

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