1. Indicate whether the following statements are true or false.

a) The time to failure of a component is distributed as follows (pdf): 𝑓(𝑡) = 0.06+𝑏𝑡2, 0 ≤ 𝑡 ≤ 10 year. We can obtain the reliability in 2 years using the provided information.

b) The time to failure of a component is distributed as follows (pdf): 𝑓(𝑡) = 𝑎 +𝑏𝑡2, 0 ≤ 𝑡 ≤ 10 year. We can obtain the reliability in 2 years using the provided information.

c) Consider a system of five pumps, each with a reliability of 90% for the mission duration. At least k pumps must properly function for the system to function and successfully complete the mission. As k increases, the system reliability, hence the likelihood of successfully completing the mission, increases.

d) Design for Reliability is a process that attempts to identify and prevent design issues early in the development phase, instead of having these issues found in the hands of the customer.

e) Life Data Analysis, Physics of Failure and FMEA are example tools used in Design for Reliability.

f) Vibration analysis, Performance Monitoring, and Root Cause Analysis are examples of predictive maintenance technologies.

g) In the risk assessment in the FMEA/FMECA, the Risk Priority Number (RPN) is obtained as follows: Severity x Occurrence x Detection. Hence the higher the RPN, the more critical the failure mode.

h) In Cause and Effect Trees (Fault Trees), the AND gate implies that at least one of many redundant equipment must fail for an event to occur.

i) If the hazard function of a component follows the bath-tub curve, its production process likely suffers from poor quality control and manufacturing defects, such as welding flaws, cracks, contamination, or poor workmanship.

j) Suppose the following failure data follows a Weibull distribution: 5.6, 3.4, 15.4, 13.2, 12.4, 17.1, 9.6, 17.5, 13.9, 15.2. The corresponding hazard function is increasing.

2. A passenger airbag (PAB) disable switch is used to deactivate the PAB in cases when the passenger seat of a car is not occupied. This saves the PAB from being wasted when the car gets into a frontal collision. The switch itself is an expensive component, so its feasibility needs to be justified based on the probability of a passenger seat being occupied when a collision happens. Available data show that a commercial van driver usually has a passenger 30% of the time. In addition, the expert opinion analysis indicates that the likelihood of the driver having an accident when the passenger seat is occupied is 40% of that of getting in a collision when the passenger seat is not occupied. Given a frontal collision has occurred, what is the probability of the passenger seat in a commercial van being occupied?

3. An engineering student must finish an important term paper to be turned in the next morning. The paper is stored on the student’s hard drive with a backup copy on a flash drive. Hence, the student can either retrieve the paper from the hard drive or the flash drive. The computer has three USB ports that can accommodate the flash drive. The system is defined to be the hard drive, the processor, the printer, the flash drive, and the USB ports. (Note that the processor needs to be operational for the computer to function.)

a) Construct the reliability block diagram so the student can complete and print the term paper.

b) What is probability (reliability) that the student will successfully finish and print term paper? We have R (hard drive) =0.9, R(processor)=0.98, R(printer)=0.95, R (flash drive) =0.9 and R (each USB port) = 0.85. c) Suppose the failure of the processor is exponential with 𝜆 = 0.0001 failures per minute. What is the maximum amount of time (in full minutes) that the student can work on the term paper to finish and print it with the probability of 0.93 or more?

4. Consider a system that uses two types of components, namely components A and B. Time to failure for component A is distributed according to Weibull with shape parameter 1.2 and characteristic life 50 days. Time to failure for component B is distributed according to Lognormal distribution whose logarithm has mean 75 hours and standard deviation 25 hours. Suppose the system consists of three component A’s and four component B’s and all components function independently. In order for the system to function, at least two component A’s and at least one component B needs to function.

a) What are the reliability of components A and B in 10 days?

b) What is the system reliability in 10 days?

5. Find the system reliability at 100 days if all system components are independent and their reliabilities at 100 days are as follows: 𝑅1 = 0.8, 𝑅2 = 0.9, 𝑅3 = 0.8, 𝑅4 = 0.9, 𝑅5 = 0.9.

