FUNDAMENTALS OF ENGINEERING STATISTICAL ANALYSIS
ISE/DSA 5013
Assignment 2

Show your work for calculation problems. You will receive no credit if you only provide the answer. Define any events which are necessary in solving probability problems. *As with all homework this semester, spend time to be neat and organized. Any disorganized submissions are subject to a zero grade.*

Problem 1

A batch of 500 Johnson rods contains five that are defective. Two are selected at random from the batch.

    a. Do you think the probability of the selection of defective (or nondefective, for that matter) Johnson rods is independent? Why?

    b. What is the probability that the second one selected is defective given that the first one was defective?

    c. What is the probability that both are defective?

    d. What is the probability that both are nondefective?

Problem 2

You're a quality control engineer working for Tinker Air Force Base. The length, width, and height of a manufactured part used in the maintenance, repair, and overhaul of a particular aircraft type are classified as being either within or outside specified tolerance limits. In a quality inspection, 86% of the parts are found to be within the specified tolerance limits for width, but only 80% of parts are within specified limits for all three dimensions. Further, 2% of the parts are within the limits for width and length but not for height, and 3% of parts are within limits for width and height but not length. Also, 92% of parts are within limits for either width or height or both. If a part is within the specified tolerance limits for height, what is the probability that it will also be within the specified limits for width?
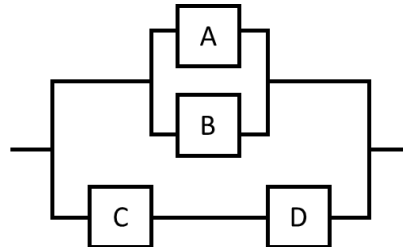
Problem 3

You're a structural engineer working for a large construction firm. You purchase structural beams from three different suppliers: 20% from supplier A1, 20% from supplier A2, and 60% from supplier A3. Based on historical evidence, 10% of the beams from A1 are not directly usable in commercial construction, same with 12% of beams from A2 and 4% from A3. What is the probability that a particular beam will not be directly usable in commercial construction?

Problem 4

Consider the system of components connected as depicted below. The system can be thought of as being comprised of two subsystems: one with components A and B, and the other with components C and D. Components A and B are connected in parallel, therefore that subsystem works iff either A or B works. Since C and D are connected in series, that subsystem works iff both C and D work. Components work independent of each other (that is, operation/failure of

one component doesn't influence the operation/failure of another). If event A is defined as "component A works" and so on, then $P(A) = 0.9$, $P(B) = 0.88$, $P(C) = 0.94$, and $P(D) = 0.98$.

    a. Calculate $P(\text{system works})$ as a function of only the $P(\cdot)$ notation – no numbers.

    b. Calculate the quantity for $P(\text{system works})$.

Problem 5

An engineering project management firm divides projects into three risk categories: 70% of projects are low risk, 20% are medium risk, and 10% are high risk. Based on historical data, a low risk has a 0.03 probability of not being completed on time, a medium risk project has a 0.11 probability of not being completed on time, and a high risk project has a 0.23 probability of not being completed on time.

    a. What is the probability that the project is low risk and is completed on time?

    b. What is the probability that a project is not completed on time?

    c. Given that the project was not completed on time, what is the probability that it was considered to be low risk?

Problem 6

The following table reports the proportions of microchips that a certain PC manufacturer purchases from seven suppliers.

    a. It is known that the proportions of defective microchips produced by the seven suppliers are 0.001, 0.0003, 0.0007, 0.006, 0.0002, 0.0002, and 0.001, respectively. If a single microchip failure is observed, what are the probabilities that each supplier is responsible?

    b. Instead assume that all suppliers produce defective microchips at the same rate of 0.0005. If a single microchip failure is observed, what are the probabilities that each supplier is responsible?

Supplier	Proportion
S1	0.15
S2	0.05
S3	0.10
S4	0.20
S5	0.12
S6	0.20
S7	0.18

Problem 7
You're a quality control inspector at a brewery, where you inspect the beer canning process. There are three production lines that produce beer cans, and you identify nonconforming beer cans according to five defect types. The table below provides the proportions of defect types for nonconforming cans for each of the three lines during a particular time period. During this period, line 1 produced 500 nonconforming cans, line 2 produced 400 such cans, and line 3 produced 600 such cans. Suppose that one of these 1500 cans was selected randomly.
  a. What is the probability that the can was produce by line 1?
  b. What is the probability that the reason for the nonconformance is a surface defect?
  c. Given that the selected can had a surface defect, what is the probability that it came from line 3?

Defect type	Line 1	Line 2	Line 3
Blemish	0.15	0.12	0.20
Crack	0.50	0.44	0.40
Pull-tab problem	0.21	0.28	0.24
Surface defect	0.10	0.08	0.15
Other	0.04	0.08	0.01

Problem 8
At an electronics manufacturing facility, based on past experience, 86% of new assembly line workers that attended the facility's training program meet the desired production quota, where only 35% of new assembly line workers that do not attend the training program meet the quota. If 80% of all new assembly line workers attend the training program, what is the probability that a new worker will meet the production quota?

Problem 9
Back at Tinker Air Force Base, an aircraft seam requires 25 rivets during an MRO operation. The seam will have to be reworked if any of these rivets is defective. Suppose rivets are defective independently of one another, each with the same probability.
  a. If 20% of all seams need reworking, what is the probability that a rivet is defective?
  b. How small should the probability of a defective rivet be to ensure that only 10% of all seams need reworking?

Problem 10
An assembler of computer routers and modems uses parts from two sources. Company A supplies 80% of the parts, and Company B supplies the remaining 20% of parts. From past experience, the assembler knows that 5% of the parts supplied by Company A are defective, and 3% of the parts supplied by Company B are defective. An assembled modem selected at random is found to have a defective part. What is the probability that the part came from Company A? Company B? (adapted from [Mendenhall and Sincich 2016], exercise 3.94).

Problem 11

You're a radar engineer working on an unmanned system to detect intruders in real time without spurious detections, both indoors and outdoors, using video cameras and microprocessors. The system was tested outdoors under various weather conditions near Barnsdall, OK. The numbers of intruders detected and missed under each condition are provided in the table below. One test result was chosen at random.

a. What is the probability that the test occurred during rainy conditions?
b. What is the probability that the test occurred in a missed intruder?
c. What is the probability that it was either clear or windy during the test?
d. Given that the test resulted in a detected intruder, what was the probability that the weather conditions were snowy?
e. Under cloudy conditions, what is the probability that the test resulted in a missed intruder?

	Clear	Cloudy	Rainy	Snowy	Windy
Intruders detected	21	228	226	7	185
Intruders missed	0	6	6	3	10