$\frac{19}{20}$

Department of Electrical and Computer Engineering

ENGR 371 Probability and Statistics in Engineering
Midterm Exam – July 20, 2015
Time: 1 hour

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SECTION:--CC--

Special Instructions:

CELL PHONES OR ANY ELECTRONIC DEVICES ARE NOT PERMITTED.

- Attempt all questions. If you have any difficulty you may try to make REASONABLE assumptions. State the assumptions and how those assumptions limit your answers. Show all your work in detail and **justify** your answers.
- Marks are given for how an answer is arrived at, not just the answer itself.
- All answers are to be written into the question papers. Use <u>the back sheets</u> and extra blank papers for your rough work.
- Show your work and put a box around your final answer. **Providing <u>ONLY</u> the Final answer (without any calculations) will earn <u>ONLY</u> a Zero in that problem.**
  - **Write Big, clear and legible. Provide a neat and professional presentation.**

Problem 1) (5 Marks)

In your company there are 6 engineers, 12 electrical technicians, 8 machinists and 4 project leaders. For the upcoming project you will need 1 project leader, 2 engineers, 3 electrical technicians and 3 machinists.

a) From the above data how many possible ways are there to form a team for the upcoming project? (2 Marks)

need 1 leader, 2 eng, 3 elect
3 machinist

30 employees

6 eng | 12 tech | 8 mach. | 4 leaders

(Select 9)

2

How many ways?

$$\binom{6}{2}\binom{12}{3}\binom{8}{3}\binom{4}{1} = (15)(220)(56)(4) = \boxed{739,200 \text{ ways}}$$

Total = 30

6 E · 12 T · 8 M · 4 L

35 SN · 25 SN

$\boxed{\text{Select 9}}$

b) If the upcoming project requires that the all engineers and project ~~managers~~ leaders on the team be able to communicate in both English and Spanish and only 3 of the engineers and two of the project managers speak both languages, how many possible ways are there to form a team for the upcoming project? (3 Marks)

4 project managers
6 engineers

required: all speak english & spanish
have: 3 engineers
2 project managers } speak both

$\binom{6}{3}\binom{4}{2} = \boxed{120 \text{ ways}}$

2

$\binom{3}{2}\binom{12}{3}\binom{8}{3}\binom{3}{1}$

Question 2) (10 Marks)

A supplier of pumps for your company has indicated that the pumps have a reliability (i.e. the pumps will work) 85% of the time to produce 1 Mega Pascal (MPA) pressure and 15% of the time that they do not produce 1 MPA, their impact on the pipeline pressure is negligible that is zero. Your project requires enough pumps to produce at least 3 MPA pressure in the pipeline in order to open a *dam shutter*. Each pump costs 1500 dollars and their performances are independent of one another. You add pumps one at a time, (each pump costing 1500 dollars), until the dam shutter opens:

a) Determine the number of pumps you must purchase in order to have at least a 60% chance of opening the dam shutter while having the minimum cost. (6 Marks)

Find # of pumps to purchase if we want 60% chance of opening dam shutter with minimum cost

$P(W) = 0.85 \Rightarrow (1\text{MPA})$
$P(W') = 0.15$
need enough pumps to produce 3MPa
1 pump = 1500 \$

required: $P(X \geq 3\text{MPa})$

Geometric

$p = 0.85$

independent → distribution
binomial, geometric or negative binomial

$P(X \geq 3) = 1 - [P(X=2) + P(X=1)]$

$P(X=2) = (1-0.85)^{2-1}(0.85) = 0.1275$

$P(X=1) = (1-0.85)^{0}(0.85) = 0.85$

$P(X \geq 3) = 1 - (0.1275 + 0.85) = 0.0225$

3

60% of 3MPa = 1.8 $\qquad P(X \geq 1.8)$

* have to purchase at least 1 pump. ! Base cost \$1500

if purchase 2 dams, $2 \times 0.85 = 1.7$

$P(X \geq 1.8) = P(X=1.8) +$ $\qquad 3 \times 0.85 = 2.55$ ✓

$P(X=1.8) = (1-0.85)^{0.8}(0.85)$ $\qquad 3 \times 1500 = \boxed{4500\ \$}$ $\boxed{3\ \text{pumps}}$

$= 0.1863339$

b) **If you purchased a batch of 8 pumps, how likely is it to have 2 or more under- performing pumps (i.e. less than 1 MPA) in the batch? (4 Marks)**

Binomial:

X = # of under performing pumps

n = 8

p = 0.15

$$\mathbb{P}(X \geq 2) = 1 - [\mathbb{P}(X=0) + \mathbb{P}(X=1)]$$

$$\mathbb{P}(X=0) = \binom{n}{x} p^x (1-p)^{n-x} = \binom{8}{0}(0.15)^0(1-0.15)^8 = 0.272491$$

$$\mathbb{P}(X=1) = \binom{n}{x} p^x (1-p)^{n-x} = \binom{8}{1}(0.15)^1(1-0.15)^7 = 0.3846925$$

$$\mathbb{P}(X \geq 2) = 1 - (0.272491 + 0.3846925)$$

$$\boxed{\mathbb{P}(X \geq 2) = 0.342817}$$

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$a \left[x^2 \right]_{0.2}^{0.8} = 1$

$a(0.6) = 1$

$a = 1.6\overline{6}$

Question 3) (10 Marks)

Answer True or False and briefly show why that is. (2 marks each):

3a) The constant "a" of the continuous random variable $f(x) = ax \ (0.2 \leq x \leq 0.8)$ equal to 0.3

ANSWER: False.

$\int_{0.2}^{0.8} ax\,dx = 1$

+2

3b) The number of holes in a road can be modeled using a Poisson Process with a rate $\lambda = 0.3$ *per millimeter*. This has an expected number of holes of 300 in one kilometer of the road.

ANSWER: False

$\frac{0.3}{mm} \times \frac{1mm}{10cm} \times \frac{1cm}{100cm} + \frac{1m}{1000km}$

$X \neq 300.$

+2

Multiple Choice: Check (√) the only one right answer in each question below:

3c) Given $P(B) = 0.8, P(A|B) = 0.4, P(A|B') = 0.2$. The value of $P(B|A)$ is (rounded to 2 decimal places.):

A) 0.01	B) 0.11	C) 0.50	D) 0.89 ✓	E) 0.99

+2

3d) A system requires at least one of four installed generators to be working. The generators have probabilities of working of: Gen A= 0.7, Gen B =0.65, Gen C= 0.75 and Gen D = 0.8 (treat these as independent events). Compute the probability that the system will be working.

A) 0.99475	B) 0.00525	C) 0.27300 ✓	0.72700	E) 0.80000

0

3e) If you were to roll two dice (each die can have a value between 1 to 6 equally likely). The mean value of the outcome of the roll is:

A) 3.5	B) 7	C) 2	D) 12	E) None of these ✓

+2

2 dice $1 \to 6$

$p = 6 \times 6 = 36$ ways

$\frac{1}{6} \cdot \frac{1}{6} = 0.02777$

$\mu = n \cdot p$

$n = 2$

$p =$

3d) required 1/4 generators working

Binomial

$n=4$, $p=$

$\mathbb{P}(X \geq 1)$

$P(A) = 0.70$ .3

$P(B) = 0.65$ .35

$P(C) = 0.75$ .25

$P(D) = 0.80$ .2

0.70 A → $(0.70)(1/4) =$

0.65 B → $(0.65)(1/4) =$

0.75 C → $(0.75)(1/4) =$

0.80 D → $(0.80)(1/4) =$

$\underbrace{\qquad\qquad}_{0.725}$

$1 - 0.725$

$= 0.275$

$1 - (0.725)^4$

3c) $P(B) = 0.8$ $P(B') = 0.20$

$P(A|B) = 0.4$ $P(A'|B) = 0.60$

$P(A|B') = 0.2$

Find $P(B|A) = \dfrac{P(A|B)P(B)}{P(A|B)P(B) + P(A|B')P(B')}$

$= \dfrac{(0.40)(0.80)}{(0.40)(0.80) + (0.20)(0.20)} = \dfrac{0.32}{0.32 + 0.04}$

$\boxed{0.8888}$