

## MTH 3240 EXAM I TOPICS

(Exam problems will be similar to homework problems and examples done in class.)

**Population versus sample:** Know the difference. Also know how to identify the population's elementary units from the description of a study.

**Random sampling: Simple random sampling, systematic random sampling:** Know what these are.

**Experiments versus observational studies:** Know the difference, and know which type of study can establish cause and effect and which type can't.

**Confounding variables:** Know what they why they make it difficult to establish cause and effect.

**Impact assessment study designs (before-after, control-impact, before-after-control-impact):** Know what these are, and know why confounding variables can be a problem in the first two.

**Statistics for summarizing a data set (sample mean, sample median, sample standard deviation):** Know what each of these tells us about a data set.

**Discrete and continuous random variables:** Know the difference.

**Probability distributions for discrete random variables and probability functions:** Know what these are and how they're used.

**Probability distributions for continuous random variables and probability density curves:** Know what these are and how they're used.

**Binomial and Poisson distributions:** Know how to recognize when each of these is an appropriate model for a random variable.

**Normal and lognormal distributions:** Know how to recognize when each of these is an appropriate model for a random variable, know that if you start with a lognormal random variable, and take its log, the result is a normal random variable.

**Percentile of a (continuous) distribution:** Know what this means.

**Sampling distribution of a statistic:** Know what this is.

**Mean and standard error (standard deviation) of the sampling distribution of  $\bar{X}$ :** Know how to obtain these ( $\mu_{\bar{X}}$  and  $\sigma_{\bar{X}}$ ) when  $\mu$ ,  $\sigma$ , and  $n$  are given. Also know how to interpret them.

**Normality of the sampling distribution of  $\bar{X}$ :** Know that it's normal when the sample came from a normal population or (by the Central Limit Theorem) when the sample size  $n$  is large.

**Estimators for a population mean ( $\mu$ ) and standard deviation ( $\sigma$ ):** Know that  $\bar{X}$  estimates  $\mu$  and  $S$  estimates  $\sigma$ .

**Confidence intervals:** Know how to interpret and use them, know their properties (e.g. how they're affected by the choice of the confidence level and the size of the sample), and know what a **margin of error** is and what it measures.

**The  $t$  distribution:** Know its properties and that when its degrees of freedom is large, it's essentially the same as the standard normal distribution.

**One sample  $t$  confidence interval for a population mean  $\mu$ :** Know how to compute and interpret this.

**Sample size determination for attaining a specified margin of error:** Know the formula for determining  $n$  when you have a specified margin of error and guess for the value of  $\sigma$ .

**One sample  $z$  confidence interval for a population proportion  $p$ :** Know how to compute and interpret this.

**Checking normality of data:** Know how to use histograms and normal probability plots to recognize that a data set *doesn't* follow a normal distribution.

**Hypothesis testing:** Know what the following terms mean.

**Null and alternative hypotheses**

**Test statistic**

**Level of significance**

**Rejection region approach vs p-value approach**

**P-value**

**Statistically significant**

**Upper-tailed, lower-tailed, and two-tailed tests**

**Steps in hypothesis testing:** Know how these are used.

1. Identify the population parameter  $\mu$ ;
2. State the hypotheses;
3. Check the assumptions (e.g. the normality or large  $n$  assumptions);
4. Choose a significance level (usually  $\alpha = 0.05$ );
5. Compute the test statistic;
6. Determine p-value or rejection region (from a table);
7. State the conclusion.

**One-sample  $t$  test for a population mean  $\mu$ :**

Know when the test is appropriate (i.e. to test for a population mean when the sample is from a normal distribution or  $n$  is large).

Know how to carry out the  $t$  test using both the *p-value* and *rejection region* approaches.

**Errors in hypothesis testing:** Know what these are:

**Type I and II errors**

**Type I error probabilities** (know how to determine the Type I error probability).

**Other topics in hypothesis testing:** Know what these mean and why they're important:

**Data snooping**

**Statistical significance vs practical importance**

**One-sample sign test for a population median  $\tilde{\mu}$**

Know when the test is appropriate (i.e. to test for a population median  $\tilde{\mu}$  when the sample is from *any* distribution).

Know how to carry out the sign test using the *p-value* approach.