## Normal Distribution Calculations Using Technology

All of the calculations that we will do in Math 180A involving the normal distribution can be done using tables. A normal distribution table will be provided on exams. However, it is recommended that you also learn how to make these calculations using either a graphing calculator or Microsoft Excel.

Below are some instructions. On the TI-83, you can follow these instructions as soon as you turn on your calculator. On the TI-89, you first have to press APPS, then select FlashApps, then scroll to Stats/List Editor, then press Enter twice. You should then see options ranging from F1-Tools to F7-Ints, and you are ready to follow the instructions below.

It will often be necessary to calculate probabilities of the form  $P(Z \leq z)$ ,  $P(Z \geq z)$ , or  $P(a \leq Z \leq b)$ , where Z has a standard normal distribution.

**Microsoft Excel**: Using Microsoft Excel, you can find probabilities of the form  $P(Z \le z)$ . For example, to find  $P(Z \le 1.26)$ , type "=normsdist(1.26)" into a cell, and you should get .8962. To find other probabilities, you can convert them into the form  $P(Z \le z)$ . For example, to find  $P(Z \ge -0.37)$ , observe that this is  $1-P(Z \le -0.37)$ , so you can type "1 - normsdist(-0.37)" to get the answer of .6443. To find  $P(-0.37 \le Z \le 1.26)$ , you can calculate  $P(Z \le 1.26) - P(Z \le -0.37)$  by typing "=normsdist(1.26) - normsdist(-0.37)" to get the answer of .5405.

**TI-83**: Press DISTR (that is, 2nd and VARS), and choose 2:normalcdf. To calculate  $P(-0.37 \le Z \le 1.26)$ , type "-0.37, 1.26, 0, 1)" to finish the command, then press ENTER. The numbers 0 and 1 that are entered correspond to the mean and standard deviation of Z respectively. You should obtain an answer of .5405. The TI-83 only calculates probabilities of the form  $P(a \le Z \le b)$  and not of the form  $P(Z \le z)$  or  $P(Z \ge z)$ . However, to find  $P(Z \le 1.26)$ , you can type a number such as -100 for the lower endpoint, so the full command becomes normcdf(-100, 1.26, 0, 1). To find  $P(Z \ge -0.37)$ , use 100 for the upper endpoint.

**TI-89**: Press F5, then scroll down to 4:normal Cdf. Then input the four numbers requested, moving from each number to the next one using the down arrow. To find  $P(-0.37 \le Z \le 1.26)$ , enter -0.37 for the Lower Value, 1.26 for the Upper Value, 0 for the mean  $\mu$ , and 1 for the standard deviation  $\sigma$ . To find  $P(Z \le 1.26)$ , use a number such as -100 for the Lower Value and 1.26 for the Upper Value. To find  $P(Z \ge -0.37)$ , use -0.37 for the Lower Value and 100 for the Upper Value.

In some problems, it will be necessary, for a given value y, to find the value of z such that  $P(Z \leq z) = y$ . These are known as inverse normal calculations and can be carried out using the instructions below.

**Microsoft Excel**: To find the value of z such that  $P(Z \le z) = .95$ , type "=normsinv(.95)" into a cell to get the answer of 1.645. That is, 95 percent of the area under the normal curve is to the left of 1.645.

**TI-83**: Press DISTR (that is, 2nd and VARS), and choose 3:invnorm. The command "invNorm(" should appear. To finish the command, type ".95, 0, 1)" to get the answer of 1.645. This means that  $P(Z \le 1.645) \approx .95$ .

**TI-89**: Press F5, then scroll down to 2:Inverse, then select 1:Inverse Normal. Type .95 for Area, 0 for  $\mu$ , and 1 for  $\sigma$  to get the answer of 1.645. This means that  $P(Z \le 1.645) \approx .95$ .