**Explanations of Quiz Solutions for Chapters 5-6**

1. Since the price of the widgets will be increasing at 3% per year and 3% per year is also the inflation rate, the price of widgets will be constant in real dollars (purchasing power). This is also true for the cost of production of widgets. Since nominal costs are increasing at the same rate as inflation, they are constant in real dollars. We use the Fischer Equation to find the Real Cost of Capital at 9.71%. Since all cash flows come at the end of the year, if we sell 1.5 million widgets for $1 each, it costs 30 cents to make each widget (gross profit of 70 cents per widget), and the tax rate is 21% (1-t = .79), we get to keep $829,500 at the end of year 1. Note that this is nominal dollars. Since our annual profit will grow at the same rate as inflation, it will be constant in real dollars. To convert the $829,500 at time 1 from nominal dollars to real dollars, we divide by 1 plus the inflation rate raised to the t power. Of course since this profit is in time 1, we don’t need to show the exponent of 1. Note that when we divide by 1.03 here, we are not discounting cash flows, we are taking nominal cash flows at time 1 and changing them to real cash flows (still at time 1). We find the present value of the annuity by using the PV function in Excel with the real profits in years 1-10 being the PMT and the real cost of capital being the RATE. The cost of the California plant is $10 million and can be expensed in the year it is built (time zero). This expense will save taxes for IWM by decreasing its total taxable income by $10 million. This is a tax savings of $10 million times the tax rate of 21%. So the net cost of the California plant is $10 million times one minus the tax rate (21%) which is $7.9 million. The NPV is the sum of the net cost of the plant at time zero plus the present value of the cash flows (profits) in years 1-10.
2. This problem is seen most easily in the Excel spreadsheet that is provided. Note that in Year 0 (time zero), the only cash flows are the capital expenditure of $250,000 and the increase in Net Working Capital (a cash outflow) of $10,000. Since the problem does not ask us to discount some cash flows at one cost of capital and other cash flows at a different cost of capital, it is easiest to use the top-down approach to find the Project Cash Flows. The Sales and Expenses were given to us for year 1 with sales growing by 5% per year and expenses growing at 3% per year. Note how we can calculate the year 2-5 values in Excel. With a capital expenditure of $250,000 being depreciated over 5 years, we have depreciation of $50,000 per year. Taxes are 21% of EBIT, leaving us with net income of $39,500 in year 1. Since depreciation was not a cash flow, we add it back in to get Operating Cash Flow of $89,500 in year 1. Years 2-5 are calculated the same way. Both the $10,000 we injected into NWC at time 0 and the additional $5,000 at time one are recovered when the project ends after 5 years. The Project Cash Flow each year is the sum of the Capital Expenditures, Changes in NWC, and Operatinal Cash Flows. The Project CF is the Free Cash Flow that we want to discount to find the NPV, or, as in this case, use to find the Internal Rate of Return. Using the IRR function in Excel, and the Project CF, we find the IRR to be 26.06% (making sure to carry out the answer to the nearest basis point).
3. Since the risky cost of capital and increases in sales and labor costs are given in real terms, I am solving this problem using real dollars for revenues, labor costs, and other costs. The lease is constant in nominal dollars, so it is easiest to use nominal dollars and the nominal risk-free rate for those cash flows. As with any problem, if you use nominal cash flows, you must use nominal growth rates and the nominal cost of capital. If you use real cash flows, you must use real growth rates and the real cost of capital. Whichever route you take, if you do it correctly, you will get the same final answer.

Since I decided to use real cash flows for Revenues, Labor Costs, and Other Costs, I need to convert them from nominal to real at time 1. Looking at Revenues, we will receive $150,000 a year from now – in nominal dollars. The purchasing power of that $150,000 will be less than that one year from now though, because what we can buy with it has increased by the 1.5% inflation rate. So to find the Real Revenues at time 1, we need to divide the Nominal Revenues by 1 plus the inflation rate raised to the t power. In this case, t=1, so we don’t need to show it in the equation. We are not discounting $150,000 in revenues back to time 0 here. We are converting them from nominal dollars to real dollars. So the purchasing power of the revenues we will be receiving next year is $147,783.25. We follow the same procedure for Labor Costs and Other Costs. Real Revenues are a growing perpetuity with an annual real growth rate of 5% and a real discount rate of 10%. The growing perpetuity formula gives us the present value of the revenues ($2,955,665.02) when we use the real revenues at time 1 along with the real growth rate and the real appropriate discount rate. We follow the same procedure with Labor Costs and Other Costs, discounting them all back to their present value.

Since the lease payments are the same every year in nominal dollars, it seems easiest to treat them as a perpetuity. We need the nominal risk-free rate though. To find it, we use the Fischer Equation and the Real Risk-free rate of 2% to calculate the nominal risk-free rate of 3.53%. Be sure to use cell referencing here since there are more decimals to the right of 3.53%. It is ok to discount the revenues, labor costs and other costs back to time 0 using real cash flows and real rates while using nominal cash flows and nominal rates for lease payments because we do not mix values in the same equation. Once everything is brought back to time zero, there is no difference between nominal and real cash flows, so they can be added together to find the NPV.

1. The options of building a new facility vs. adding on to the existing facility are mutually exclusive. The first step is to find the IRR of each possibility and compare them with the cost of capital (10%). If the IRR of only one of the options exceeds 10%, do that option. If neither of them do, don’t do either option. If both of them do, we need to look at the incremental IRR to make a decision about option to choose. Though the solution shows the use of the depreciation tax shield, you will get the same answer if you use the top-down approach. Looking at the cash flow from the new building, we see that it is $2 million per year before taxes and before our depreciation tax savings. Since Franco’s tax rate is 21%, they get to keep 79% of the revenue ($1,580,000). Additionally, Franco’s will save $210,000 in taxes each year because the $10 million cost of the new facility is depreciated on a straight-line basis over 10 years, thus allowing them to subtract $1 million from their taxable income each year (they save 21 cents in taxes for every dollar they reduce their taxable income by). Since both the after-tax revenue and the Depreciation Tax Shield occur each of the next 10 years, the cash flows can be added together resulting in an operating cash flow of $1,790,000 per year for 10 years. Finding the IRR of the new facility means using the IRR function in Excel. Remember that the IRR is the cost of capital (the r) which causes the NPV to equal zero. The IRR of the new building is 12.28%, which is greater than the cost of capital. The same procedure is followed to find an IRR of 22.37% for the Add-on option. Again, this is greater than the cost of capital, so both options are worth doing. But since only one can be done, we need to find the incremental IRR. The incremental (additional) cost of building a new building instead of doing the add-on is $9.5 million ($10 million minus $500,000). The incremental yearly free cash flow (each year for the next 10 years) is $1,661,000 ($1,790,000 minus $129,000). The incremental IRR is calculated the same way the IRR for the new building and add-on were calculated in Excel. Use the cash flows from time 0-10 and the IRR function. Since the incremental IRR of 11.70% exceeds the cost of capital, going above and beyond the addition – and building a new building is a good project (it exceeds the cost of capital), making it a good use of the additional investment.
2. Revenues and Variable Costs are growing at different rates for the next three years, so we list them separately. We also show their values in year 4 as we will need that to calculate their terminal values. The cash flows in years 1-3 are calculated individually. In year 1, we take the Revenues (6 million) minus the variable costs (3 million) on an after-tax basis (we multiply by .79 because the marginal tax rate is 21%, so 1-.21 = .79). These risky cash flows are discounted back to time zero at the cost of capital of 12%. Also in year 1 (as well as year 2), we are able to reduce our taxes due to a depreciation tax shield. The amount we depreciate is $.5 million and we are in the 21% tax bracket, so .5 million times .21 is how much money we save in taxes. Since this tax savings is considered to be risk-free, we want to discount it at the risk-free rate of 3%. We do the same thing in years 2 and 3 except that the depreciation schedule ends after year 2. We now have all the free cash flows from years 1-3 brought back to time 0 except the fixed costs.

Since both the Revenues and the Variable Costs grow at 3% starting at time 3, we can combine them to find the terminal value at time 3 for the Revenues and Variable Costs. To get the terminal value at time 3, we need the cash flows at time 4 (given earlier) on an after-tax basis (why we multiply by .79). Dividing the after-tax CF at time 4 by r minus g (.12 - .03) gives us the terminal value of Revenues minus Variable Costs at time 3 as $36.8633223 million (you should be carrying these values out in Excel to avoid any rounding errors). The present value of that terminal value at time 3 is found by dividing by one plus the cost of capital raised to the third power. The after-tax Fixed Costs are a simple perpetuity, so we divide their after-tax cash flow each year by the cost of capital. The Revenues, Variable Costs, Fixed Costs, and depreciation tax shield have now all been brought back to time zero at their appropriate discount rates. The value of any company is the present value of its future cash flows, discounted at the appropriate discount rates. For Robinstats, that means we add the discounted year 1, year 2, and year 3 cash flows together with the discounted terminal value cash flows. But since none of those values included fixed costs, we need to subtract the present value of the fixed costs. Ths gives us the value of the company.

1. When projecting the project cash flows to use in an NPV or IRR problem, it is important to use the incremental cash flows – that is, the cash flows if you do the project vs. the cash flows if you don’t do the project. For that reason, in this problem, when we decide to sell the old machine which still had two years of depreciation left on its schedule, we must account for the depreciation tax shield that we are losing in addition to the depreciation tax shield that we are gaining when we purchase the new machine. In year 0 (the present), we spend $72,000 on the new machine, but receive $20,000 from the sale of the old machine. In years 1-5, we cut operating expenses by $24,000 per year with the new machine (vs. what our expenses would have been with the old machine), but of course, account for the tax effect since expenses are deducted from revenues before determining the taxes that are due. So we multiply the $24,000 savings by one minus the tax rate to find the net savings of $18,960 per year. The new machine is depreciated on a straight-line basis, so we depreciate 72,000/5 = 14,400 per year. Since the amount of taxes saved each year is the amount depreciated multiplied by the marginal tax rate (21%), we gain a depreciation tax shield of $3,024 each year. As mentioned above, as soon as we sell the old machine for its book value of $20,000, we lose the opportunity to depreciate it by $10,000 each of the next two years. Had we depreciated it by $10,000 each year, our tax savings would have been the depreciation amount multiplied by the tax rate, equaling $2,100 each year. Since we won’t have this tax savings after we sell the machine, this appears as an opportunity cost (negative value) on the spreadsheet. Remember that when we calculate the NPV of a project, the NPV function in Excel requires us to use the cash flows in times 1-N, and then separately add in the cash flow at time 0 (we add it because it is already listed as a negative cash flow).
2. For each of the three projects, calculating the NPV is simply discounting the cash flows in time 1 by one plus the discount rate (12%) raised to the first power, discounting the cash flows in time 2 by one plus the discount rate raised to the second power, and adding these values to the negative cash flow at time 0. Remember that the NPV function in Excel requires that we only list the cash flows in time 1 and 2 – not time 0. We must separately subtract the cost at time zero to get the true NPV.

IRR is the cost of capital (discount rate) that causes the NPV to equal 0. So for each project, we set NPV equal to zero and solve for the discount rate. In Excel, we use the IRR function and highlight all three cash flows (times 0-3). It is not necessary to enter a value for guess as we know there will only be one IRR for each project.

All three of these projects are worth doing as they all have positive NPVs and IRRs which exceed the cost of capital (relevant discount rate). However, since they are mutually exclusive, we can only do one of the three and must decide which one is best. Project B has the highest NPV but the lowest IRR. When comparing mutually exclusive projects, we always want to do the project with the highest NPV, because it makes the most money.

1. For each year (0-5) we must sum the three components of the Project Cash Flow. They are the Operational Cash Flow, the Capital Expenditures, and the Changes in Net Working Capital. At time 0, there are no Operational Cash Flows yet since those cash flows come at the end of each year. We do spend $850,000 on the new software though and we do need to inject $25,000 of net working capital into the company. While increases in NWC are a cash outflow, they are not an expense. The new software is an expense that can be subtracted from total company revenues in the year that it is purchased (time zero). Thus the net cash flow from the purchase of the new software is $850,000 times one minus the tax rate (21%). So although the new software costs $850,000, its purchase results in a net cash outflow of only $671,500. We can use the top-down approach because we are discounting all cash flows at the same cost of capital (18%). Note that we can easily calculate our revenues and expenses each year through cell referencing. Taxes are 21% of EBIT, leaving us with our net income each year. Since we are not depreciating the purchase of the new software, our net income in years 1-5 is equal to our operating cash flow. The only other cash flow is the recovery of the increase in NWC that comes at the end of the life of the software (the project). A decrease in NWC is a cash inflow. Once we have all the project cash flows in years 0-5, we can use Excel to calculate both NPV and IRR as described in earlier problems.
2. In this problem, it specifically states that the cash flow from the tax savings due to depreciation are to be considered to be risk-free. This makes it very difficult to use the top-down approach because we need to use two different discount rates. I suggest finding the present value of the revenues and costs separately and then the present value of the depreciation tax shield.

After-tax revenues are growing at 3% per year for 7 years, so we can use the growing annuity formula to find the present value of the after-tax revenues. The revenues in the first year are $500,000. After taxes, they are $395,000 ( which is $500,000 (1-.21)). Their present value is $2,012,628.24. The costs are not growing each year, so we can use the present value of an annuity formula. Again, we want to find their present value after taxes, so we multiply $200,000 by one minus the marginal tax rate (21%). This gives us a present value of the after-tax costs of $744,527.01. The depreciation tax shield is how much we save on taxes each year due to depreciation. It is the amount depreciated each year times the marginal tax rate. Since the initial cost was $1.2 million and it is depreciated on a straight-line basis to zero over the seven years of the project, the amount of depreciation each year is $1.2 million/7 ( which equals $171,428.57). The tax shield is the annual depreciation times 21% ($36,000). Since this is the same each year and is known with certainty at time zero, we use the PV of an annuity formula with the risk-free rate of 2% to find the present value of $232,991.68. To find the NPV of the project, add the initial cost (-$1.2 million) the PV of the revenues, the PV of the costs (remember that this is a cost so it has a negative value) and the PV of the depreciation tax shield.

1. This problem is similar to some of the earlier problems except that this one includes a terminal value. Note that the year 6 sales and expenses are each 3% more than the year 5 sales and expenses. This is because the operating cash flows are expected to grow at a rate of 3% per year in perpetuity starting at time 5. The terminal value at time 5 is the operating cash flow at time 6 divided by (r-g). This is the growing perpetuity formula we learned earlier in the course. This terminal value at time 5 ($880,638) is the OCF from 6 thru infinity brought back to year 5. The terminal value at time 5 can now be added to the operating cash flow at time 5 giving us a total cash flow of $1,017,287 at time 5 which needs to be discocunted back to time zero along with the cash flows at times 1-4. The NPV function in excel discounts the cash flows from times 1-5, with the negative cash flow at time 0 being added in to give us the net present value of this project.