Understanding Financial Management: A Practical Guide
Problems and Answers

Chapter 8
Capital Budgeting

8.2 – 8.8 Capital Budgeting Techniques (NPV, PI, IRR, MIRR, PP, and DPP)

1. Fair Trade Tea Company (FTTC) is considering investing $200,000 to expand its operations. The firm's required rate of return is 12% and the firm expects to reinvest any cash inflows at this rate. Management has set the maximum payback period as 3 years and the maximum discounted payback period at 4 years. The firm estimates that year-end cash flows will be as follows:

Fair Trade Tea Company Net Cash Flows						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Net cash flow	-$200,000	$50,000	$54,000	$60,000	$68,000	$75,000

Using each of the follow techniques, should the firm accept the project? Why or why not?

A. Net present value
B. Profitability index
C. Internal rate of return
D. Modified internal rate of return
E. Payback period
F. Discounted payback period

2. Coltrane Recordings is considering investing in a new project with an unconventional cash flow pattern. The company's cost of capital is 13% and the firm expects to reinvest any cash inflows at this rate. Management has set the maximum discounted payback period at 4 years. The initial investment and year-end cash flows are listed below.

Coltrane Recordings Net Cash Flows						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Net cash flow	-$500,000	$160,000	$180,000	$-60,000	$220,000	$260,000

Using each of the following discounted cash flow techniques, should the firm accept the project? Why or why not?

A. Net present value
B. Profitability index
C. Internal rate of return
D. Modified internal rate of return
F. Discounted payback period

8.9 Mutually Exclusive Projects

3. Conglomerate Inc. is considering two mutually exclusive projects with the following estimated year-end cash flows:

Year	Project A	Project B
0	-$350,000	-$350,000
1	90,000	170,000
2	110,000	150,000
3	140,000	120,000
4	210,000	100,000

The firm's cost of capital is 15% and the firm expects to reinvest any cash inflows at this rate. Management set the maximum payback period at 3 years and the maximum discounted payback period at 3.5 years. Using each of the follow techniques, which project is preferable? Why?

A. Net present value
B. Profitability index
C. Internal rate of return
D. Modified internal rate of return
E. Payback period
F. Discounted payback period

4. Waldorf Suppliers is evaluating two mutually exclusive machines -- Model 300 or Model 100. The firm requires an 11% rate of return and has sufficient financing to undertake either project. Analysts had done some preliminary analysis of these two projects as shown below.

Mutually Exclusive Projects – Model 100 and Model 300				
Year	**Model 300**	**Rank**	**Model 100**	**Rank**
0	-$350,000		-$200,000	
1	120,000		70,000	
2	120,000		70,000	
3	120,000		70,000	
4	120,000		70,000	
NPV @ 11%	$22,293	1	$17,171	2
PI	$1.06	2	$1.09	1
IRR	13.95%	2	14.96%	1
MIRR @ 11%	12.73%	2	13.31%	1

A. Why does a conflict exist between the rankings or Model 300 and Model 100?
B. Based solely on the information provided, which project is preferable? Why?

5. Dyna Corp. can undertake one of two mutually exclusive projects – Project X or Project Y. The firm's required rate of return on either project is 14%. Analysts have developed the following table that ranks the two projects. Assume year-end cash flows.

Mutually Exclusive Projects -- Projects X and Y				
Year	**Project X**	**Rank**	**Project Y**	**Rank**
0	-$160,000		-$160,000	
1	10,000		120,000	
2	80,000		80,000	
3	150,000		5,000	
NPV @ 14%	$11,575	1	$10,195	2
PI @ 14%	$1.07	1	$1.06	2
IRR	17.19%	2	19.16%	1
MIRR @ 14%	16.69%	1	16.37%	2

A. Why does a conflict exist between the rankings of Projects X and Y?
B. Which project, if any, should the firm take? Why?

6. Chesapeake Products Inc. requires a new machine. Two companies have submitted bids. Chesapeake's cost of capital is 12%. Analysts provide the following preliminary analysis of these two mutually exclusive Projects A and B:

Mutually Exclusive Projects –Projects A and B				
Year	**Project A**	**Rank**	**Project B**	**Rank**
0	-$200,000		-$200,000	
1	100,000		20,000	
2	80,000		70,000	
3	60,000		100,000	
4	40,000		120,000	
NPV @ 12%	$21,189	1	$21,101	2
PI @ 12%	$1.1059	1	$1.1055	2
IRR	17.80%	1	15.92%	2
MIRR @ 12%	14.86%	1	14.84%	2

A. Which project is preferable? Why?
B. At what cost of capital do the two projects have the same net present value? That is, what is the crossover rate?
C. Given the following information, what decision should the firm make at each discount rate? (Fill in the column under "Decision").

NPVs for Projects A and B at Different Discount Rate Intervals			
Discount Rate (%)	**NPV**		**Decision**
	Project A	**Project B**	
6	$47,600	$60,181	Accept B
8	38,211	46,119	Accept B
10	29,424	33,126	Accept B
11.95	21,384	21,384	Either
12	21,189	21,101	Accept A
14	13,458	9,953	Accept A
16	6,191	-397	Accept A
18	-650	-10,020	Neither

D. Using the information in the table directly above, plot the NPV profile, crossover rate, and IRR.

7. Brandywine Industries wants to invest in a new system and has narrowed the choice down to System Alpha and System Zeta. The company only wants to invest in one system. System Alpha has a life of four years and System Zeta has life of eight years. The company's cost of capital is 12%.
   - System Alpha requires an initial investment of $130,000 and then generates positive after-tax cash flows of $50,000 at the end of each of the next four years. At the end of four years, the expected salvage value of the original system is zero. However, the firm expects to be able to buy another System Alpha at a cost of $150,000 that will generate after-tax cash flows of $60,000 a year for another four years at which time the salvage value will again be zero.
   - System Zeta has an initial cash outflow of $140,000 and subsequent year-end cash inflows are $35,000. After eight years, management expects this system will have an after-tax salvage value of $10,000.

   Analysts have developed the following table showing their preliminary analysis of the two systems.

Mutually Exclusive Projects – System Alpha and System Zeta				
Year	**System Alpha**	**Rank**	**System Zeta**	**Rank**
0	-$130,000		-$140,000	
1	50,000		35,000	
2	50,000		35,000	
3	50,000		35,000	
4	50,000		35,000	
5			35,000	
6			35,000	
7			35,000	
8			45,000	
NPV @ 12%	$21,867	2	$37,906	1
PI @ 12%	1.17	2	1.27	1
IRR	19.77%	1	19.20%	2
MIRR @ 12%	16.44%	1	15.41%	2

A. If Brandywine does not plan to replace System Alpha at the end of its life, why do conflicting rankings exist among the various measures?
B. If Brandywine does not plan to replace System Alpha at the end of its life, which system should the firm select? Why?
C. If Brandywine plans to replace the System Alpha after four years, what is the net present value on the eight-year extended basis of the system that adds more value to the firm? (Note: Use the replacement chain method).

8. An analyst at Singleton Company has the responsibility of recommending the purchase of personal computers. The analyst has narrowed the choices to two mutually exclusive models of differing quality. Compared with the EXP 1000, the EXP 5000 is a quick, higher quality model.
   - *Model EXP 5000*. The analyst estimates that each computer will cost $3,000, require yearly maintenance of $150, and have an after-tax salvage value of $400 at the end of its four-year life. The analyst expects an after-tax labor cost savings of $1,400 per year due to this model's quicker speed.
   - *Model EXP 1000*. The analyst estimates that each computer will cost $1,500, require $200 in yearly maintenance, and have a $250 after-tax salvage value at the end of the three-year life. The analyst expects an after-tax labor cost savings of $1,150 per year due to the slower speed of this model.

   The analyst assumes that comparable machines are available at the end of each machine's useful life. Using an 11% discount rate, what is the better computer choice? (Note: Use the equivalent annual annuity (EAA) method).

9. West Coast Corporation has decided to replace the air-conditioning system for the company's headquarters building. Management has narrowed the choice to two systems: (1) a standard system that is expected to last 10 years and cost $400,000 and (2) a deluxe system that is expected to last 15 years and cost $600,000. Neither system will generate cash flows directly or have any salvage value. If management requires a 12.5% required

return, which system is preferable? (Note: Use the equivalent annual charge (EAC) method).

10. Polk Company plans to buy a machine for $90,000 and requires a return of 11%. The year-end after-tax cash flows and after-tax abandonment values are shown below. Calculate the NPV and EAA for each year.

Cash Flows and Abandonment (Salvage) Value					
Year	**0**	**1**	**2**	**3**	**4**
Cash flow	-$90,000	$50,000	$30,000	$15,000	$12,000
Abandon value	90,000	55,000	29,000	20,000	0

A. If Polk Company cannot invest in an identical asset, when should the firm abandon the project?
B. If Polk Company can invest in an identical asset, when should the firm abandon the project? (Note: In this situation, assume that the decision involves mutually exclusive investments (i.e., the project has three abandonment times). In addition, assume that the firm can reinvest in an identical asset (i.e., abandonment frees up funds for use in buying an identical investment).

11. Riddick Supply Company can sell a machine today and receive $2,000,000 after taxes. Alternately, the firm can continue using the machine, receive year-end cash inflows of $450,000 for six years, and an after-tax salvage value of $200,000 at the end of the sixth year. The company's required rate of returns is 9%. Should Riddick sell the machine today or continue to use the machine?

8.10 Capital Rationing

12. Cleantex Inc. has set a capital budget of $700,000 for the next year. Management has identified four potential capital investments. The firm requires a 10% return on any project selected. The financial manager has developed the following information about each independent project.

Ranking Projects by NPV, PI, and IRR							
Project	**Initial Investment**	**NPV**	**Rank**	**PI**	**Rank**	**IRR**	**Rank**
A	$400,000	$225,000	1	1.56	3	24%	2
B	350,000	210,000	2	1.60	2	19	3
C	300,000	80,000	4	1.27	4	11	4
D	200,000	125,000	3	1.63	1	28	1
Total	$1,250,000	$640,000					

Given this information, what project(s) should the firm accept?

Answers

1A. The project's NPV is:

$$NPV = -\$200{,}000 + \frac{\$50{,}000}{(1.12)^1} + \frac{\$54{,}000}{(1.12)^2} + \frac{\$60{,}000}{(1.12)^3} + \frac{\$68{,}000}{(1.12)^4} + \frac{\$75{,}000}{(1.12)^5} = \$16{,}170$$

Note: The NPV is rounded to the nearest dollar.

Discounting the net cash inflows in years 1 – 5 by 12%, provides the present values shown in the following table.

Fair Trade Tea Company Net Cash Flows						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Net cash flow	-$200,000	$50,000	$54,000	$60,000	$68,000	$75,000
PV of NCF		44,643	43,048	42,707	43,215	42,557
Sum of PVs	$216,170					

Note: The present values are rounded to the nearest dollar.

Subtracting the initial investment of $200,000 from the sum of the present values of the cash inflows produces a NPV of $16,170 = $216,170 - $200,000. Thus, the present value of the benefits ($216,170) exceeds the present value of the costs ($200,000). The firm should accept the project because a positive NPV increases shareholder wealth by $16,170.

Using the BA II PLUS® financial calculator, the Project's NPV is:

Calculating the NPV Using the BA II PLUS®			
Key Strokes	**Explanation**	**Display**	
2nd Format 2 Enter	Display 2 decimals (Need to do this only once)	DEC =	2.00
CF 2nd CLR WORK	Clear Memory Registers	CF_0 =	0.00
200,000 +/- ENTER	Initial Cash Outlay	CF_0 =	-200,000.00
↓ 50,000 ENTER	Period 1 Cash Flow	C01 =	50,000.00
↓	Frequency of Cash Flow 1	F01 =	1.00
↓ 54,000 ENTER	Period 2 Cash Flow	C02 =	54,000.00
↓	Frequency of Cash Flow 2	F02 =	1.00
↓ 60,000 ENTER	Period 3 Cash Flow	C03 =	60,000.00
↓	Frequency of Cash Flow 3	F03 =	1.00
↓ 68,000 ENTER	Period 4 Cash Flow	C04 =	68,000.00
↓	Frequency of Cash Flow 4	F04 =	1.00
↓ 75,000 ENTER	Period 5 Cash Flow	C05 =	75,000.00
↓	Frequency of Cash Flow 5	F05 =	1.00
I = 12 ENTER	12% Discount Rate	I =	12.00
↓ NPV CPT	Calculate NPV	NPV =	16,170.38

1B. The project's profitability index (PI) is:

$$PI = \frac{\frac{\$50{,}000}{(1.12)^1} + \frac{\$54{,}000}{(1.12)^2} + \frac{\$60{,}000}{(1.12)^3} + \frac{\$68{,}000}{(1.12)^4} + \frac{\$75{,}000}{(1.12)^5}}{\$200{,}000} = \frac{\$216{,}170}{\$200{,}000} = 1.08$$

Note: The sum of the present values of the cash inflows is rounded to the nearest dollar

The present value of the year-end cash flows = $216,170 and the initial cash outlay = $200,000. Thus, the PI = $216,170/$200,000 = 1.08. The firm should accept the project because for every dollar invested, it will earn about 8 cents beyond the required rate of return.

1C. Using an iterative, trial-and-error process, the project's internal rate of return (IRR) is:

$$0 = -\$200{,}000 + \frac{\$50{,}000}{(1+IRR)^1} + \frac{\$54{,}000}{(1+IRR)^2} + \frac{\$60{,}000}{(1+IRR)^3} + \frac{\$68{,}000}{(1+IRR)^4} + \frac{\$75{,}000}{(1+IRR)^5}$$

Trial and error gives an IRR = 14.99%.

Using the BA II PLUS® financial calculator, the Project's NPV is:

Calculating the IRR Using the BA II PLUS®			
Key Strokes	**Explanation**	**Display**	
2nd Format 2 Enter	Display 2 decimals (Need to do this only once)	DEC =	2.00
CF 2nd CLR WORK	Clear Memory Registers	CF_0 =	0.00
200,000 +/- ENTER	Initial Cash Outlay	CF_0 =	-200,000.00
↓ 50,000 ENTER	Period 1 Cash Flow	C01 =	50,000.00
↓	Frequency of Cash Flow 1	F01 =	1.00
↓ 54,000 ENTER	Period 2 Cash Flow	C02 =	54,000.00
↓	Frequency of Cash Flow 2	F02 =	1.00
↓ 60,000 ENTER	Period 3 Cash Flow	C03 =	60,000.00
↓	Frequency of Cash Flow 3	F03 =	1.00
↓ 68,000 ENTER	Period 4 Cash Flow	C04 =	68,000.00
↓	Frequency of Cash Flow 4	F04 =	1.00
↓ 75,000 ENTER	Period 5 Cash Flow	C05 =	75,000.00
↓	Frequency of Cash Flow 5	F05 =	1.00
IRR CPT	Calculate IRR	IRR =	14.99

The firm should accept the project because the IRR (14.99%) is greater than the required rate of return (12%). Thus, the firm benefits by accepting the project.

1D. Using 12% as the reinvestment rate, the project's modified internal rate of return (MIRR) is:

$$\$200{,}000 = \frac{\$50{,}000(1.12)^4 + \$54{,}000(1.12)^3 + \$60{,}000(1.12)^2 + \$68{,}000(1.12)^1 + \$75{,}000}{(1+\text{MIRR})^5}$$

$$\$200{,}000 = \frac{\$78{,}676 + \$75{,}866 + \$75{,}264 + \$76{,}160 + \$75{,}000}{(1+\text{MIRR})^5}$$

$$\$200{,}000 = \frac{\$380{,}966}{(1+\text{MIRR})^5}$$

Note: The cash flows are rounded to the nearest dollar.

Solve for MIRR = 13.76%

To solve for the project's MIRR using the BA II PLUS®, input the relevant data and compute I/Y.

5 N; 200,000 +/- PV; 380,966 FV; CPT I/Y = 13.7552% or about 13.76%.

The firm should accept the project because the MIRR (13.76%) is greater than the required rate of return (12%). In this situation, the MIRR (13.76%) is less than the IRR (14.99%) because the assumed reinvestment rate using the MIRR (12%) is less than the assumed reinvestment rate using the IRR (14.99%).

1E. As the following table shows, finding the payback period (PP) for the projects involves determining when the cumulative net cash flows (NCF) of a project equals zero.

Cumulative Net Cash Flows						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Net cash flow	-200,000	50,000	54,000	60,000	68,000	75,000
Cumulative NCF	-200,000	-150,000	-96,000	-36,000	32,000	107,000

$$\text{PP} = 3 + \frac{36{,}000}{68{,}000} = 3.53 \text{ years}$$

The firm should reject the project because the PP of 3.53 years exceeds management's maximum PP of 3 years.

1F. The following table shows the project's cumulative discounted net cash flows (NCF).

Cumulative Net Cash Flows						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Net cash flow	-200,000	50,000	54,000	60,000	68,000	75,000
Discounted NCF		44,643	43,048	42,707	43,215	42,557
Cumulative discounted NCF	-200,000	-155,357	-112,309	-69,602	-26,387	16,170

Note: The present values of the cash inflows are rounded to the nearest dollar.

$$\text{DPP} = 4 + \frac{26{,}387}{42{,}557} = 4.62 \text{ years}$$

The firm should reject the project because the DPP of 4.62 years exceeds management's maximum DPP of 4 years.

2A. The project's NPV is:

$$\text{NPV} = -\$500{,}000 + \frac{\$160{,}000}{(1.13)^1} + \frac{\$180{,}000}{(1.13)^2} + \frac{-\$60{,}000}{(1.13)^3} + \frac{\$220{,}000}{(1.13)^4} + \frac{\$260{,}000}{(1.13)^5} = \$17{,}024$$

Note: The NPV is rounded to the nearest dollar.

Discounting the net cash inflows in years 1 – 5 by 13%, provides the present values shown in the following table.

Fair Trade Tea Company Net Cash Flows						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Net cash flow	-$500,000	$160,000	$180,000	$-60,000	$220,000	$260,000
PV of NCF		141,593	140,966	-41,583	134,930	141,118
Sum of PVs	$517,024					

Note: The present values are rounded to the nearest dollar.

Subtracting the initial investment of $500,000 from the sum of the present values of the cash inflows produces a NPV of $17,024 = $517,024 - $500,000. Thus, the present value of the benefits ($517,024) exceeds the present value of the costs ($500,000). The firm should accept the project because a positive NPV increases shareholder wealth by $17,024.

Using the BA II PLUS® financial calculator, the Project's NPV is:

Calculating the NPV Using the BA II PLUS®			
Key Strokes	**Explanation**	**Display**	
2nd Format 2 Enter	Display 2 decimals (Need to do this only once)	DEC =	2.00
CF 2nd CLR WORK	Clear Memory Registers	CF_0 =	0.00
500,000 +/- ENTER	Initial Cash Outlay	CF_0 =	-500,000.00
↓ 160,000 ENTER	Period 1 Cash Flow	C01 =	160,000.00
↓	Frequency of Cash Flow 1	F01 =	1.00
↓ 180,000 ENTER	Period 2 Cash Flow	C02 =	180,000.00
↓	Frequency of Cash Flow 2	F02 =	1.00
↓ 60,000 +/- ENTER	Period 3 Cash Flow	C03 =	-60,000.00
↓	Frequency of Cash Flow 3	F03 =	1.00
↓ 220,000 ENTER	Period 4 Cash Flow	C04 =	220,000.00
↓	Frequency of Cash Flow 4	F04 =	1.00
↓ 260,000 ENTER	Period 5 Cash Flow	C05 =	260,000.00
↓	Frequency of Cash Flow 5	F05 =	1.00
NPV 13 ENTER	13% Discount Rate	I =	13.00
↓ CPT	Calculate NPV	NPV =	17,024.02

The firm should accept the project because the NPV is positive.

2B. The project's profitability index (PI) is:

$$PI = \frac{\frac{\$160{,}000}{(1.13)^1} + \frac{\$180{,}000}{(1.13)^2} + \frac{-\$60{,}000}{(1.13)^3} + \frac{\$220{,}000}{(1.13)^4} + \frac{\$260{,}000}{(1.13)^5}}{\$500{,}000} = \frac{\$517{,}024}{\$500{,}000} = 1.03$$

Note: The sum of the present values of the cash inflows is rounded to the nearest dollar

The firm should accept the project because for the PI is greater than 1.00. For every dollar invested, the firm will earn about 3 cents beyond its required rate of return.

2C. Using an iterative, trial-and-error process, the project's internal rate of return (IRR) is:

$$0 = -\$500{,}000 + \frac{\$160{,}000}{(1+IRR)^1} + \frac{\$180{,}000}{(1+IRR)^2} + \frac{-\$60{,}000}{(1+IRR)^3} + \frac{\$220{,}000}{(1+IRR)^4} + \frac{\$260{,}000}{(1+IRR)^5}$$

Trial and error gives an IRR = 14.28%.

Using the BA II PLUS® financial calculator, the Project's NPV is:

Calculating the NPV Using the BA II PLUS®			
Key Strokes	**Explanation**	**Display**	
2nd Format 2 Enter	Display 2 decimals (Need to do this only once)	DEC =	2.00
CF 2nd CLR WORK	Clear Memory Registers	CF_0 =	0.00
500,000 +/- ENTER	Initial Cash Outlay	CF_0 =	-500,000.00
↓ 160,000 ENTER	Period 1 Cash Flow	C01 =	160,000.00
↓	Frequency of Cash Flow 1	F01 =	1.00
↓ 180,000 ENTER	Period 2 Cash Flow	C02 =	180,000.00
↓	Frequency of Cash Flow 2	F02 =	1.00
↓ 60,000 +/- ENTER	Period 3 Cash Flow	C03 =	-60,000.00
↓	Frequency of Cash Flow 3	F03 =	1.00
↓ 220,000 ENTER	Period 4 Cash Flow	C04 =	220,000.00
↓	Frequency of Cash Flow 4	F04 =	1.00
↓ 260,000 ENTER	Period 5 Cash Flow	C05 =	260,000.00
↓	Frequency of Cash Flow 5	F05 =	1.00
IRR CPT	Calculate IRR	IRR =	14.28

The firm should accept the project because the IRR (14.28%) is greater than the firm's required rate of return (13%).

2D. Using 13% as the reinvestment rate, the project's modified internal rate of return (MIRR) is:

$$\$500{,}000 + \frac{\$60{,}000}{(1.13)^3} = \frac{\$160{,}000(1.13)^4 + \$180{,}000(1.13)^3 + \$220{,}000(1.13)^1 + \$260{,}000}{(1+\text{MIRR})^5}$$

$$\$500{,}000 + \$41{,}583 = \frac{\$260{,}876 + \$259{,}721 + \$248{,}600 + \$260{,}000}{(1+\text{MIRR})^5}$$

$$\$541{,}583 = \frac{\$1{,}029{,}197}{(1+\text{MIRR})^5}$$

Note: The cash flows are rounded to the nearest dollar.

Solve for MIRR = 13.70%

The following table shows the cash flows for this project.

Calculating the MIRR						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Net cash flow	-500,000	160,000	180,000	-60,000	220,000	260,000
Discounted CF		260,876	259,721	-41,5831	248,600	260,000
PV of cash outflows	-541,583					
FV of cash inflows	1,029,197					
MIRR	13.70%					

To solve for the project's MIRR using the BA II PLUS®, input the relevant data and compute I/Y.

5 N; 541,583 +/- PV; 1,029,197 FV; CPT I/Y = 13.70%.

The firm should accept the project because the MIRR (13.70%) exceeds its required rate of return (13%).

2E. The following table shows the project's cumulative discounted net cash flows (NCF).

Cumulative Net Cash Flows						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Net cash flow	-500,000	160,000	180,000	-60,000	220,000	260,000
Discounted NCF		141,593	140,966	-41,583	134,930	141,118
Cumulative discounted NCF		-358,407	-217,441	-259,024	-124,094	6,169

Note: The present values of the cash inflows are rounded to the nearest dollar.

$$\text{DPP} = 4 + \frac{124{,}094}{141{,}118} = 4.88 \text{ years}$$

The firm should reject the project because the DPP of 4.88 years is longer than the firm's benchmark of 4 years.

3A. The net present value (NPV) of Project A and B is:

Project A

$$NPV_A = -\$350{,}000 + \frac{\$90{,}000}{(1.15)^1} + \frac{\$110{,}000}{(1.15)^2} + \frac{\$140{,}000}{(1.15)^3} + \frac{\$210{,}000}{(1.15)^4} = \$23{,}557.13$$

Project B

$$NPV_B = -\$350{,}000 + \frac{\$170{,}000}{(1.15)^1} + \frac{\$150{,}000}{(1.15)^2} + \frac{\$120{,}000}{(1.15)^3} + \frac{\$100{,}000}{(1.15)^4} = \$47{,}324.91$$

Using the BA II PLUS® financial calculator, the NPV for Project A is:

Calculating the NPV of Project A Using the BA II PLUS®			
Key Strokes	**Explanation**	**Display**	
2nd Format 2 Enter	Display 2 decimals (Need to do this only once)	DEC =	2.00
CF 2nd CLR WORK	Clear Memory Registers	CF_0 =	0.00
350,000 +/- ENTER	Initial Cash Outlay	CF_0 =	-350,000.00
↓ 90,000 ENTER	Period 1 Cash Flow	C01 =	90,000.00
↓	Frequency of Cash Flow 1	F01 =	1.00
↓ 110,000 ENTER	Period 2 Cash Flow	C02 =	110,000.00
↓	Frequency of Cash Flow 2	F02 =	1.00
↓ 140,000 ENTER	Period 3 Cash Flow	C03 =	140,000.00
↓	Frequency of Cash Flow 3	F03 =	1.00
↓ 210,000 ENTER	Period 4 Cash Flow	C04 =	210,000.00
↓	Frequency of Cash Flow 4	F04 =	1.00
NPV 15 ENTER	15% Discount Rate	I =	15.00
↓ CPT	Calculate NPV	NPV =	23,557.13

Using *Excel*, Project A's NPV is:

Calculating the NPV of Project A Using *Excel*

	A	B	C	D	E	F
1	Project A					
2	k =	15%				
3	Time	0	1	2	3	4
4	Cash flow	-350,000	90,000	110,000	140,000	210,000
5	NPV =	$23,557.13				
6	IRR =					
7	MIRR =					

In *Excel*, the formula in B5 is: **=B4+NPV(B2,C4:F4)**, which produces an NPV of $23,557.13.

Project B is preferred to Project A, because Project B's NPV ($47,324.91) is higher than Project A's NPV ($23,557.13). Thus, Project B should be accepted because it adds $23,767.78 ($47,324.91 - $23,557.13) more in wealth to the firm than Project A.

3B. The profitability index (PI) of Projects A and B is:

Project A

$$PI_A = \frac{\frac{\$90,000}{(1.15)^1} + \frac{\$110,000}{(1.15)^2} + \frac{\$140,000}{(1.15)^3} + \frac{\$210,000}{(1.15)^4}}{\$350,000} = \frac{\$373,557.13}{\$350,000.00} = 1.07$$

Project B

$$PI_B = \frac{\frac{\$170,000}{(1.15)^1} + \frac{\$150,000}{(1.15)^2} + \frac{\$120,000}{(1.15)^3} + \frac{\$100,000}{(1.15)^4}}{\$350,000} = \frac{\$397,324.91}{\$350,000.00} = 1.14$$

Compared to Project A, Project B is preferred because Project B's PI (1.14) is higher than Project A's PI (1.07). A PI of 1.14 suggests that Project B will generate $1.14 of present value for every dollar initially invested in the project; whereas a PI of 1.07 indicates that Project A will generate $1.07 of present value for every dollar initially invested. Given the initial investment is the same for both Projects A and B ($350,000), Project B will increase shareholder wealth by more than Project A.

3C. Using an iterative, trial-and-error process, the internal rate of return (IRR) of Projects A and B eventually results in the following:

$$0 = -350,000 + \frac{\$90,000}{(1+IRR_A)^1} + \frac{\$110,000}{(1+IRR_A)^2} + \frac{\$140,000}{(1+IRR_A)^3} + \frac{\$210,000}{(1+IRR_A)^4}$$

$$0 = -350,000 + \frac{\$170,000}{(1+IRR_B)^1} + \frac{\$150,000}{(1+IRR_B)^2} + \frac{\$120,000}{(1+IRR_B)^3} + \frac{\$100,000}{(1+IRR_B)^4}$$

Trial and error gives an IRR_A = 17.85% and an IRR_B = 22.23%.

The following table illustrates how to calculate the IRR for Project A using a BA II PLUS® financial calculator.

Calculating the IRR_A Using the TI BA II PLUS®			
Key Strokes	**Explanation**	**Display**	
CF 2nd CLR WORK	Clear Memory Registers	CF_0 =	0.00
350,000 +/- ENTER	Initial Cash Outlay	CF_0 =	-350,000.00
↓ 90,000 ENTER	Period 1 Cash Flow	C01 =	90,000.00
↓	Frequency of Cash Flow 1	F01 =	1.00
↓ 110,000 [ENTER]	Period 2 Cash Flow	C02 =	110,000.00
↓	Frequency of Cash Flow 2	F02 =	1.00
↓ 140,000 ENTER	Period 3 Cash Flow	C03 =	140,000.00
↓	Frequency of Cash Flow 3	F03 =	1.00
↓ 210,000 ENTER	Period 4 Cash Flow	C04 =	210,000.00
↓	Frequency of Cash Flow 4	F04 =	1.00
IRR CPT	Calculate IRR	IRR =	17.85

Using *Excel*, Project A's IRR is:

Calculating the IRR of Project A Using *Excel*

	A	B	C	D	E	F
1	Project A					
2	k =	15%				
3	Time	0	1	2	3	4
4	Cash flow	-350,000	90,000	110,000	140,000	210,000
5	NPV =					
6	IRR =	17.85				
7	MIRR =					

The formula in Cell B6: **=IRR(B4:F4)**.

If the firm's cost of capital is 15%, Project B is preferred to Project A because Project B's IRR (22.23%) is higher than Project A's IRR (17.85%). Given the initial investment is the same for both Projects A and B ($350,000), Project B will increase shareholder wealth by more than Project A.

3D. Using the cost of capital of 15% as the reinvestment rate, the modified internal rate of return (MIRR) of Projects A and B is:

Project A

$$\$350{,}000 = \frac{\$90{,}000(1.15)^3 + \$110{,}000(1.15)^2 + \$140{,}000(1.15)^1 + \$210{,}000}{(1+\text{MIRR}_A)^4}$$

$$\$350{,}000 = \frac{\$136{,}878.75 + \$145{,}475 + \$161{,}000 + \$210{,}000}{(1+\text{MIRR}_A)^4}$$

$$\$350{,}000 = \frac{\$653{,}353.75}{(1+\text{MIRR}_A)^4}$$

Solve for $\text{MIRR}_A = 16.89\%$

Project B

$$\$350{,}000 = \frac{\$170{,}000(1.15)^3 + \$150{,}000(1.15)^2 + \$120{,}000(1.15)^1 + \$100{,}000}{(1+\text{MIRR}_B)^4}$$

$$350{,}000 = \frac{\$258{,}548.75 + \$198{,}375.00 + \$138{,}000.00 + \$100{,}000.00}{(1+\text{MIRR}_B)^r}$$

$$\$350{,}000 = \frac{\$694{,}923.75}{(1+\text{MIRR}_B)^4}$$

Solve for $\text{MIRR}_B = 18.70\%$

To solve for the MIRR for Project A using the BA II PLUS®, input the relevant data and compute I/Y.

4 N; 350,000 +/- PV; 653,353.75 FV; CPT I/Y = 16.89%.

Using *Excel*, Project A's MIRR is:

Calculating the MIRR of Project A Using *Excel*						
	A	**B**	**C**	**D**	**E**	**F**
1	Project A					
2	k =	15%				
3	Time	0	1	2	3	4
4	Cash flow	-350,000	90,000	110,000	140,000	210,000
5	NPV =					
6	IRR =					
7	MIRR =	16.89				

The formula in Cell B7 is: **=MIRR(B4:F4,15%,15%)**

If the firm's cost of capital and reinvestment rate is 15%, Project B is preferred to Project A since Project B's MIRR (18.70%) is higher than Project A's MIRR (16.89%). Given the initial investment is the same for both Projects A and B ($350,000), Project B will increase shareholder wealth more than Project A due to its higher MIRR.

3E. As the following table shows, finding the payback period (PP) for Projects A and B involves determining when the cumulative net cash flows (NCF) of each project equals zero.

Cumulative Net Cash Flows for Projects A and B						
Project	**Year**	**0**	**1**	**2**	**3**	**4**
A	Net cash flow	-350,000	90,000	110,000	140,000	210,000
	Cumulative NCF	-350,000	-260,000	-150,000	-10,000	200,000
B	Net cash flow	-350,000	170,000	150,000	120,000	100,000
	Cumulative NCF	-350,000	-180,000	-30,000	90,000	190,000

$$PP_A = 3 + \frac{10{,}000}{210{,}000} = 3.05 \text{ years} \qquad PP_B = 2 + \frac{30{,}000}{120{,}000} = 2.25 \text{ years}$$

If the firm's maximum acceptable PP is 3 years, only Project B, with a PP of 2.25 years, is below the maximum. Project A's PP of 3.05 years exceeds the maximum acceptable PP and thus this project is unacceptable. Thus, Project B is preferred to project A.

3F. The following table shows the cumulative discounted net cash flows (NCF) of each project.

Cumulative Discounted Net Cash Flows for Projects A and B					
Year	**0**	**1**	**2**	**3**	**4**
Project A					
Net cash flow	-350,000	90,000.00	110,000.00	140,000.00	210,000.00
Discounted NCF		78,260.87	83,175.80	92,052.27	120,068.18
Cumulative discounted NCF	-350,000	-271,739.13	-188,563.33	-96,511.06	23,557.12
Project B					
Net cash flow	-350,000	170,000.00	150,000.00	120,000.00	100,000.00
Discounted NCF		147,826.09	113,421.55	78,901.95	57,175.32
Cumulative discounted NCF	-350,000	-202,173.91	-88,752.36	-9,850.41	47,324.91

$$DPP_A = 3 + \frac{96{,}511.06}{120{,}068.18} = 3.80 \text{ years} \qquad DPP_B = 3 + \frac{9{,}850.41}{57{,}175.32} = 3.17 \text{ years}$$

If the firm's maximum acceptable DPP is 3.5 years, only Project B, with a DPP of 3.17 years, is below the maximum. Project A's DPP of 3.80 years exceeds the maximum acceptable DPP and thus this project is unacceptable. Project B is preferred to Project A.

4A. A conflict exists between the NPV and the other DCF techniques (PI, IRR, and MIRR) because Model 300 is larger than Model 100, $350,000 versus $200,000. That is, the projects have different initial investments.

4B. Although the PI, IRR, and MIRR favor Model 100 over Model 300, the firm should accept Model 300 because it has a higher NPV ($22,293 versus $17,171), and thus maximizes shareholder wealth. PI does not reflect differences in investment scale because it ignores the size of the project. Furthermore, return measures expressed in percentage terms (IRR and MIRR) cannot discriminate between projects of different sizes.

5A. NPV, PI, and MIRR rank Project X higher than Project Y, but IRR ranks Project Y higher than Project X. Both projects have the same initial investments ($160,000) and life spans (3 years). However, these mutually exclusive projects have different cash flow patterns. The cash flow pattern for Project X increases over time whereas the cash flow pattern for Project Y decreases over time. Different rankings sometimes results from the reinvestment rate assumptions

5B. The firm should choose Project X over Project Y. NPV and MIRR, which use the required rate of return as the appropriate discount rate, are higher in Project X. Thus, these measures give a more accurate forecast of the projects true profitability. Furthermore, the PI for Project X is also higher, indicating that this project yields a higher return relative to its investment size, which is the same for Projects X and Y, than Project Y. Project Y has a higher IRR but this is largely due its high cash flow of $120,000 in year 1. One of the major drawbacks of IRR is its implicit assumption that cash flows are reinvested at the IRR, not at the required rate of return.

6A. Project A is preferable because all four capital budgeting techniques (NPV, PI, IRR, and MIRR) rank Project A over Project B. However, the results of the discounted cash flow techniques are highly similar between the two projects. Although there are no conflicts in rankings based on the current estimates of the cash flows, small changes in the cash flows, the discount rate, or both could result in conflicting rankings.

6B. Find the differential cash flows by subtracting Project B's cash flows from Projects A's cash flows for each year. Input these cash flows into a financial calculator's cash flow register and solve for the IRR to get the crossover rate of 11.95%.

Crossover Rate for Project A and Project B			
Year	**Project A [1]**	**Project B [2]**	**Differential CFs [1] – [2]**
0	-$200,000	-$200,000	0
1	100,000	20,000	80,000
2	80,000	70,000	10,000
3	60,000	100,000	-40,000
4	40,000	120,000	-80,000
Crossover rate	11.9512%		
NPV at crossover rate	$61,384		

Using the BA II PLUS®, input the differential cash flows to calculate the IRR as follows:

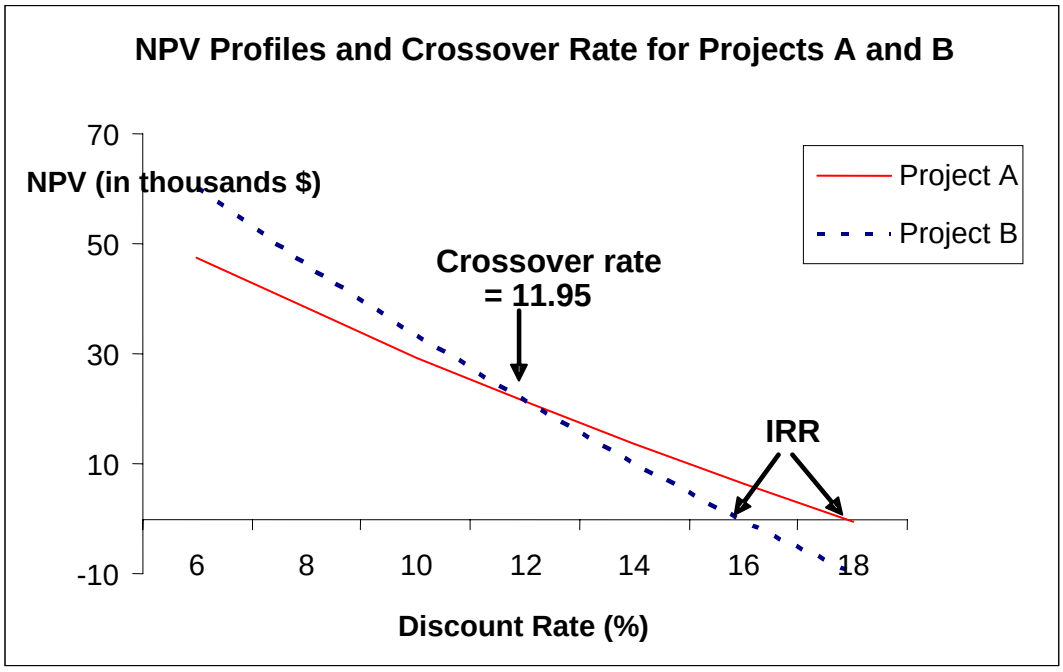
CF 2nd CLR WORK
0 ENTER
↓ 80,000 ENTER
↓ ↓ 10,000 ENTER
↓ ↓ 40,000 - ENTER
↓ ↓ 80,000 - ENTER
↓ IRR CPT

The IRR = 11.95%. The crossover rate is the point where the two machines will have the same NPV. At the crossover rate, the firm should be indifferent about which project (machine) to accept because both projects will have the same NPV = $61,384. Since the discount (12%) is greater than the crossover rate (11.95%), no conflict exists between the rankings of Projects A and B based on the NPV or IRR.

6C. The following tables show the decision for each discount rate.

NPVs for Projects A and B at Different Discount Rate Intervals			
Discount Rate (%)	**NPV**		**Decision**
	Project A	**Project B**	
6	$47,600	$60,181	Accept B
8	38,211	46,119	Accept B
10	29,424	33,126	Accept B
11.95	21,384	21,384	Either
12	21,189	21,101	Accept A
14	13,458	9,953	Accept A
16	6,191	-397	Accept A
18	-650	-10,020	Neither

6D. The NPV profiles and crossover rate for Projects A and B are:



7A. System Alpha has higher rankings than System Zeta based on the IRR (19.77% versus 19.20%) and MIRR (16.44% versus 15.41%). Yet, System Zeta has higher rankings than System Alpha based on the NPV ($37,906 versus $21,867) and PI (1.27 versus 1.17). The conflicting rankings result from different lives (four years for System Alpha and eight years for System Zeta) and different initial investments ($130,000 for System Alpha and $140,000 for System Zeta).

7B. If Brandywine does not plan to replace System Alpha at the end of its life, the preliminary analysis shown in the table above indicates that the firm should buy System Zeta because it creases more value for the firm, $37,906 for System Zeta versus $21,867 for System Alpha.

7C. To find the NPV of the system requires using the replacement chain approach.

Using Replacement Chains for Mutually Exclusive Projects with Different Economic Lives				
Year	**System Alpha**	**Rank**	**System Zeta**	**Rank**
0	($130,000)		($140,000)	
1	50,000		35,000	
2	50,000		35,000	
3	50,000		35,000	
4	-100,000*		35,000	
5	60,000		35,000	
6	60,000		35,000	
7	60,000		35,000	
8	60,000		45,000	
NPV @ 12%	$42,357	1	$37,906	2
Year 4, System Alpha: $50,000 cash inflow - $150,000 cash outflow = -$100,000				

With the BA II PLUS® calculator, input the following to get the NPV of System Alpha and System Zeta:

System Alpha		**System Zeta**
CF 2nd CLR WORK		CF 2nd CLR WORK
130,000 +/- ENTER		140,000 +/- ENTER
↓ 50,000 ENTER		↓ 35,000 ENTER
↓ 3 ENTER		↓ 7 ENTER
↓ 100,000 +/- ENTER		↓ 45,000 ENTER
↓ ↓ 60,000 ENTER		NPV 12 ENTER
↓ 4 ENTER		↓ CPT
NPV 12 ENTER		
↓ CPT		
NPV_{Alpha} = $42,357.18		NPV_{Zeta} = $37,906.22

Using the replacement chain approach, Brandywine should accept System Alpha because its NPV of $42,357 is greater than System Zeta's NPV of $37,906. Thus, System Alpha adds $4,451 ($42,357 - $37,906) more in value than System Zeta.

8. The cash flows for the two computers are as follows:

Estimated Cash Flows for Two Mutually Exclusive Personal Computers					
Year	0	1	2	3	4
Model EXP 5000					
Initial investment	-$3,000				
After-tax labor savings		$1,400	$1,400	1,400	$1,400
Maintenance costs		- 150	-150	-150	-150
After-tax salvage value					400
Total cash flow	-$3,000	$1,250	$1,250	$1,250	$1,650
Model EXP 1000					
Initial investment	-$1,500				
After-tax labor savings		$1,150	$1,150	$1,150	
Maintenance costs		-200	-200	-200	
After-tax salvage value				250	
Total cash flow	-$1,500	$950	$950	$1,200	

The steps using the BA II PLUS® calculator to get the NPV of the two mutually exclusive computers are:

Model EXP 5000		Model EXP 1000
CF 2nd CLR WORK		CF 2nd CLR WORK
3,000 - ENTER		1,500 - ENTER
↓ 1,250 ENTER		↓ 950 ENTER
↓ 3 ENTER		↓ 2 ENTER
↓ 1,650 ENTER		↓ 1,200 ENTER
↓ NPV 11 ENTER		↓NPV 11 ENTER
↓ CPT		↓ CPT
$NPV_{EXP\ 5000}$ = 1,141.55		$NPV_{EXP\ 1000}$ = 1,004.33

Based on the NPV, the EXP 5000 ranks higher than the EXP 1000 ($1,441.55 versus $1,004.33, respectively). Because the two models have different lives, the equivalent annual annuity (EAA) for each model is:

Model EXP 5000		Model EXP 1000
4 N		3 N
11 I/Y		11 I/Y
1,141.55 - PV		1,004.33 - PV
CPT PMT		CPT PMT
$EAA_{EXP\ 5000}$ = 367.95		$EAA_{EXP\ 1000}$ = 410.98

Based on the EAA, the EXP 1000 ranks higher than the EXP 5000 ($410.98 versus $367.95). The analyst should recommend EXP 1000 over EXP 5000 due to the higher EAA.

9. The EAC for each system is shown below:

Standard System		Deluxe System
10 N		15 N
12.5 I/Y		12.5 I/Y
400,000 +/- PV		600,000 +/- PV
CPT PMT		CPT PMT
$EAC_{Standard}$ = 72,248.71		$EAC_{EXP\ 1000}$ = 90,458.25

Management should prefer the standard system over the deluxe system because of its lower EAC ($72,248.71 versus $90.458.25).

10A. If Polk Company cannot invest in an identical asset, the firm should abandon the machine after the third year because the NPV of $4,985 is maximized at that time.

10B. If Polk Company can invest in an identical asset, the firm should abandon the machine after one year because the EAA of $5,100 is higher than in the other year. Abandonment at the end of the first year is optimal provided if abandonment frees up fund for reuse. Over time, the NPV would be maximized by abandoning at the end of the first year and replacing the machine with an identical one that the firm abandons when it is one year old, and so on.

NPVs and EAAs of Abandonment Options							
Abandonment Period	**Cash Flows for Each Year**					**No investment in an identical asset**	**Invest in an identical asset**
	0	**1**	**2**	**3**	**4**	**NPV**	**EAA**
No abandonment	-$90,000	$50,000	$30,000	$15,000	$12,000	-$1,734	-$559
Abandon after 3 years	-90,000	50,000	30,000	35,000		4,985	2,040
Abandon after 2 years	-90,000	50,000	59,000			2,931	1,711
Abandon after 1 year	-90,000	105,000				4,595	5,100

11. Riddick Supply Company should continue to use the machine for another six years because the PV of $2,137,917 is greater than the PV of selling the machine today for $2,000,000. Alternatively, the NPV shows that retaining the machine for another six years will increase shareholder value by $137,917.

Present Value and NPV of Abandonment Options				
Year	**0**	**1 - 5**	**6**	**Present Value**
Abandonment now	$2,000,000	$0	$0	$2,000,000.00
Abandon after 6 years	0	450,000	650,000	2,137,916.83
NPV	$137,916.83			

Using the BA II PLUS® calculator, the NPV is calculated as follows:

NPV
CF 2nd CLR WORK
2,000,000 +/- ENTER
↓ 450,000 ENTER
↓ 5 ENTER
↓ 650,000 ENTER
↓ NPV 9 ENTER
↓ CPT
NPV = 137,916.83

12. Cleantex should select the projects with the highest combined NPV that is within its capital budget of $700,000. Thus, the firm should select Projects A and D because they yield the highest combined NPV and the total initial investment of $600,000 does not exceed the firm's capital budget.

Combined NPVs of Various Project Combinations		
Project Combinations	**Total Investment**	**Combined NPV**
A and D	$600,000	$350,000
B and D	550,000	335,000
A and C	700,000	305,000
B and C	650,000	290,000
C and D	500,000	205,000