(b) If the firm's MARR is 10%, which alternative is the better choice?

7.42 Which of the capital investment projects in Figure P7.42 would you choose, and why?

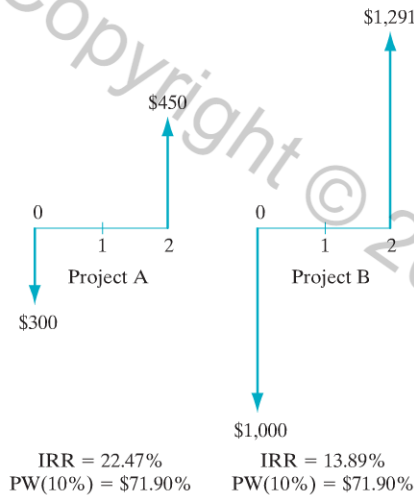IRR = 22.47% IRR = 13.89%
PW(10%) = $71.90% PW(10%) = $71.90%

Figure P7.42

(a) Select Project A because it has a larger IRR.
(b) Select Project B because it has a larger cash flow.
(c) Select either one because both have the same NPW.
(d) None of the above.

*7.43 Consider the two mutually exclusive investment projects given in Table P7.43.

TABLE P7.43

	Net Cash Flow	
n	**Project A**	**Project B**
0	−$300	−$800
1	0	1,150
2	690	40
i^*	51.66%	46.31%

Assume that MARR = 15%.

(a) According to the IRR criterion, which project would be selected?
(b) Sketch the PW(i) function on the incremental investment (B − A).

7.44 You are considering two types of automobiles. Model A costs $18,000 and model B costs $15,624. Although the two models are essentially the same, after four years of use, model A can be sold for $9,000, while model B can be sold for $6,500. Model A commands a better resale value because its styling is popular among young college students. Determine the rate of return on the incremental investment of $2,376. For what range of values of your MARR is model A preferable?

*7.45 A plant engineer is considering the two types of solar water heating system given in Table P7.45.

TABLE P7.45

	Model A	**Model B**
Initial cost	$8,000	$12,000
Annual savings	$900	$1,100
Annual maintenance	$150	$100
Expected life	20 years	20 years
Salvage value	$500	$600

The firm's MARR is 12%. On the basis of the IRR criterion, which system is the better choice? "Do nothing" is an option.

7.46 Consider the investment projects given in Table P7.46.

Assume that MARR = 15%.

(a) Projects A and B are mutually exclusive. Assuming that both projects can be repeated for an indefinite period, which one would you select on the basis of the IRR criterion?
(b) Suppose projects C and D are mutually exclusive. According to the IRR criterion, which project would be selected?
(c) Suppose projects E and F are mutually exclusive. Which project is better according to the IRR criterion?

TABLE P7.46

			Net Cash Flow			
n	A	B	C	D	E	F
0	−$100	−$200	−$4,000	−$2,000	−$2,000	−$3,000
1	60	120	2,410	1,400	3,700	2,500
2	50	150	2,930	1,720	1,640	1,500
3	50	—	—	—	—	—
*i**	28.89%	21.65%	20.86%	34.12%	121.95%	23.74%

7.47 Fulton National Hospital is reviewing ways of cutting the cost of stocking medical supplies. Two new systems are being considered to lower the hospital's holding and handling costs. The hospital's industrial engineer has compiled the relevant financial data for each system as given in Table P7.47 (dollar values are in millions).

The system life of eight years represents the period that the contract with the medical suppliers is in force. If the hospital's MARR is 10%, which system is the most economical?

7.48 Consider the cash flows for the investment projects given in Table P7.48.

TABLE P7.47

	Current Practice	Just-in-Time System	Stockless Supply System
Start-up cost	$0	$3	$6
Annual stock holding cost	$6	$1.8	$0.4
Annual operating cost	$3	$2	$1.5
System life	8 years	8 years	8 years

TABLE P7.48

			Project Cash Flow		
n	A	B	C	D	E
0	−$1,000	−$1,000	−$2,000	$1,000	−$1,200
1	900	600	900	−300	400
2	500	500	900	−300	400
3	100	500	900	−300	400
4	50	100	900	−300	400

Assume that the MARR = 12%.

(a) Suppose A, B, and C are mutually exclusive projects. Which project would be selected on the basis of the IRR criterion?

(b) What is the borrowing rate of return (BRR) for project D?

(c) Would you accept project D at MARR = 20%?

(d) Assume that projects C and E are mutually exclusive. Using the IRR criterion, which project would you select?

7.49 Consider the investment projects given in Table P7.49.

Assume that MARR = 15%.

(a) Compute the IRR for each project.

(b) On the basis of the IRR criterion, if the three projects are mutually exclusive investments, which project should be selected?

TABLE P7.49

	Net Cash Flow		
n	Project 1	Project 2	Project 3
0	−$1,500	−$5,000	−$2,200
1	700	7,500	1,600
2	2,500	600	2,000

7.50 Consider the two investment alternatives given in Table P7.50.

The firm's MARR is known to be 15%.

(a) Compute the IRR of project B.

(b) Compute the NPW of project A.

(c) Suppose that projects A and B are mutually exclusive. Using the IRR, which project would you select?

7.51 The following information on four mutually exclusive projects is given here.

All four projects have the same service life and require investment in year 0 only one. Suppose that you are provided with the following additional information about incremental rates of return between projects.

IRR(B − A) = 85%   IRR (D − C) = 25%
IRR (B − C) = 30%   IRR (A − D) = 50%

TABLE P7.50

	Net Cash Flow	
n	Project A	Project B
0	−$10,000	−$20,000
1	5,500	0
2	5,500	0
3	5,500	40,000
IRR	30%	?
PW(15%)	?	6301

TABLE P7.51

Project	Required Investment at Year 0	IRR
A	1000	56%
B	1200	67%
C	1500	43%
D	2500	49%

Which project would you choose based on the rate-of-return criterion at a MARR of 29%?

7.52 The E. F. Fedele Company is considering acquiring an automatic screwing machine for its assembly operation of a personal computer. Three different models with varying automatic features are under consideration. The required investments are $360,000 for model A, $380,000 for model B, and $405,000 for model C. All three models are expected to have the same service life of eight years. The financial information from Table P7.52, in which model (B − A) represents the incremental cash flow determined by subtracting model A's cash flow from model B's, is available.

If the firm's MARR is known to be 12%, which model should be selected?

TABLE P7.52

Model	IRR (%)
A	30
B	15
C	25
Model	**Incremental IRR (%)**
(B − A)	5
(C − B)	40
(C − A)	15

7.53 The GeoStar Company, a leading manufacturer of wireless communication devices, is considering three cost-reduction proposals in its batch job-shop manufacturing operations. The company has already calculated rates of return for the three projects, along with some incremental rates of return, as given in Table P7.53.

TABLE P7.53

Incremental Investment	Incremental Rate of Return (%)
$A_1 - A_0$	18
$A_2 - A_0$	20
$A_3 - A_0$	25
$A_2 - A_1$	10
$A_3 - A_1$	18
$A_3 - A_2$	23

A_0 denotes the do-nothing alternative. The required investments are $420,000 for A_1, $550,000 for A_2, and $720,000 for A_3. If the MARR is 15%, what system should be selected?

7.54 A manufacturer of electronic circuit boards is considering six mutually exclusive cost-reduction projects for its PC-board manufacturing plant. All

have lives of 10 years and zero salvage values. The required investment and the estimated after-tax reduction in annual disbursements for each alternative are given in Table P7.54a, along with computed rates of return on incremental investments in Table P7.54b.

TABLE P7.54a

Proposal A_j	Required After-Tax Investment	Savings	Rate of Return (%)
A_1	$60,000	$22,000	34.8
A_2	100,000	28,200	25.2
A_3	110,000	32,600	26.9
A_4	120,000	33,600	25.0
A_5	140,000	38,400	24.3
A_6	150,000	42,200	25.1

TABLE P7.54b

Incremental Investment	Incremental Rate of Return (%)
$A_2 - A_1$	8.9
$A_3 - A_2$	42.7
$A_4 - A_3$	0.0
$A_5 - A_4$	20.2
$A_6 - A_5$	36.3

If the MARR is 15%, which project would you select based on the rate of return on incremental investment?

7.55 Baby Doll Shop manufactures wooden parts for dollhouses. A worker is paid $8.10 an hour and using a handsaw can produce a year's required production (1,600 parts) in just eight 40-hour weeks. That is, the worker averages five parts per hour when working by hand. The shop is considering purchasing a power band saw with associated fixtures to

improve the productivity of this operation. Three models of power saw could be purchased: Model A (the economy version), model B (the high-powered version), and model C (the deluxe high-end version). The major operating difference between these models is their speed of operation. The investment costs, including the required fixtures and other operating characteristics, are summarized in Table P7.55.

Assume that MARR = 10%. Are there enough savings to purchase any of the power band saws? Which model is most economical, based on the rate-of-return principle? (Assume that any effect of income tax has been already considered in the dollar estimates.) (*Source*: This problem is adapted with the permission of Professor Peter Jackson of Cornell University.)

Unequal Service Lives

*7.56 Consider the two mutually exclusive investment projects given in Table P7.56 for which MARR = 15%.

On the basis of the IRR criterion, which project would be selected under an infinite planning horizon with project repeatability likely?

7.57 Consider the two mutually exclusive investment projects given in Table P7.57.

(a) To use the IRR criterion, what assumption must be made in comparing a set of mutually exclusive investments with unequal service lives?

(b) With the assumption made in part (a), determine the range of MARRs which will indicate that project A1 should be selected.

TABLE P7.55

Category	By Hand	Model A	Model B	Model C
Production rate (parts/hour)	5	10	15	20
Labor hours required (hours/year)	320	160	107	80
Annual labor cost (@ $8.10/hour)	$2,592	$1,296	$867	$648
Annual power cost ($)	—	400	420	480
Initial investment ($)	—	4,000	6,000	7,000
Salvage value ($)	—	400	600	700
Service life (years)	—	20	20	20

TABLE P7.56

	Net Cash Flow	
n	Project A	Project B
0	−$5,000	−$10,000
1	3,000	8,000
2	4,000	8,000
3	4,000	—
IRR	49.49%	39.97%

TABLE P7.57

	Net Cash Flow	
n	**Project A1**	**Project A2**
0	−$10,000	−$15,000
1	5,000	20,000
2	5,000	—
3	5,000	—

Short Case Studies

ST7.1 *Will That be Cash, Credit—or Fingertip*?[11] Have you ever found yourself short of cash or without a wallet when you want to buy something? Consider the following two types of technologies available in retail stores to speed up checkouts.

- **Pay By Touch** ™ takes fingerprints when customers enroll in the program. The image is then converted to about 40 unique points of the finger. Those points are stored in a computer system with "military-level encryption." They want this to be your cash replacement because of the time savings, and a lot of customers who are paying cash will find it more convenient now to use these cards.

- **A contactless card** allows the shopper to pay in seconds by waving his or her contactless card in front of a reader, which lights up and beeps to tell the shopper the transaction is done. A contactless payment is twice as fast as a no-signature credit card purchase and three times as fast as using cash. That's why it's catching on at fast-food restaurants and convenience stores.

Profits depend, in part, on how quickly customers—typically with small purchases—get through the line. These new technologies being rolled out at convenience stores, supermarkets, and gas stations could someday make it passé to carry bulky wallets. Without the need to dig for cash and checks at the register, the quick stop-and-go payments promise speedier transactions for consumers—and perhaps fatter profits for retailers.

The appeal is that there is no need to run anything through a machine. A contactless-card transaction is usually more expensive for a retailer to process than a cash payment. But retailers that adopt contactless payments hope they'll bring in more customers, offsetting higher costs. If that turns out to be false, then some could turn their backs on the new technology.

One retailer who just installed a Pay By Touch™ system hopes to increase its customer traffic so that a 10% return on investment can be attained. The Pay By Touch™ scanners cost about $50 each, the monthly service fee ranges between $38 and $45, and each transaction fee costs 10 cents. In a society driven by convenience, anything that speeds up the payment process attracts consumers. But technology providers will need to convince consumers of the safety of their information before the technologies can become a staple in the checkout line.

Suppose that you are a national franchise operator with 28,000 stores. As a part of growth strategy, you are thinking about installing the Pay-By-Touch™ systems (say, two systems for each store location). What kinds of additional revenue per store would justify the investment, if you are looking for at least 20% return on your investment?

ST7.2 Critics have charged that, in carrying out an economic analysis, the commercial nuclear power

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[11] "Will That be Cash, Credit—or Fingertip?" Kathy Chu, *USA Today*, Section B1, Friday, December 2, 2005.