ECE 472F Problem Set #6 Solutions – Fall, 2015

Question 1 (a)	**A**	**B**	**C**
B - Recreation	420	260	590
D - Congestion	55	50	90
D - Pollution	7	5	15
C - Construction	275	225	440
R - Fees	40	10	70

First Line		Benefits	Disbenefits	Fees	Net Ben.	B/C
Second Line		Costs		Fees	Net Costs	

Step 1: Least expensive (B) versus "Do Nothing":

B/C =	260	55	10	195	**0.91**
	225		10	215	

Therefore, "Do Nothing" wins.

Step 2: Next most expensive versus winner of Step 1 (A versus "Do Nothing"):

B/C =	420	62	40	318	**1.35**
	275		40	235	

Therefore, "A" wins.

Step 3: Next most expensive versus winner of Step 2 (C versus A):

B/C =	170	43	30	97	**0.72**
	165		30	135	

Therefore, "A" wins.

Recommend Alternative A as being the best proposal.

(b) Use sensitivity analysis and multiply the Fee Revenue in C by (1 + x) in Step 3. Let B/C = 1.0 and solve for x. Any percentage increase above x in Fee Revenue would make Alternative C the best.

B = (590 - 420) - (105 - 62) - (70 (1 + x) - 40)
C = (440 - 275) - (70 (1 + x) - 40)

Let B/C = 1 and solve for x.

This equation does not have a solution for x; therefore, no amount of revenue fee increase will make Alternative C better than Alternative A.

Question 2

(a) With B/C ratio analysis, must use incremental analysis starting with least cost alternative and compare it to the next most costly alternative.

	Annual Costs	Annual Benefits
Ferry	5,000,000	6,000,000
Low Bridge	$30{,}000{,}000\,(A/P\ 8,15)^{0.1168} + 1{,}800{,}000 = 5{,}304{,}000$	9,000,000
2nd Bridge Design	$37{,}000{,}000\,(A/P\ 8,15)^{0.1168} + 2{,}500{,}000 = 6{,}821{,}600$	11,200,000

Ferry vs. "Do Nothing"

$\Delta B/C = \frac{6{,}000{,}000}{5{,}000{,}000} = 1.2$ Accept ferry contract.

Low Bridge vs. Ferry

$\Delta B/C = \frac{3{,}000{,}000}{304{,}000} = 9.9$ Accept low bridge.

Second Bridge Design vs. Low Bridge

$\Delta B/C = \frac{2{,}200{,}000}{1{,}517{,}600} = 1.5$ Accept second bridge design.

∴ Recommend the second bridge design

(b) The "opportunity cost" approach involves raising the interest rate to the point where the projects with B/C > 1 remaining have a first cost in total that is less the budget. Therefore, fewer projects will be acepted.

(c) Re-evaluate the recommedation to go from low bridge to second design:

$B/C = \frac{2{,}200{,}000}{7{,}000{,}000\,(A/P\ \hat{i},15) + 700{,}000} = 1$

where $\hat{i}$ is the break-even interest rate.

$\therefore (A/P\ \hat{i},15) = 0.214$

$\Rightarrow \hat{i} \approx 20\%$.

Therefore, the second bridge is not in the public interest if the interest rate is greater than 20%.

Question 3

Construction Costs	100,000	
Useful life	10	
Residual Value	20,000	
Op Costs	18,000	
Hours/day	14	
Days/year	320	
Hourly charge	$4.50	per court
MARR	10%	

(a) There are two courts and each goes for $4.50 per hour. Let x equal the number of hours that the courts, in total, are rented and solve for AW = 0.

AW = -100,000 (A|P 10%,10) + 20,000 (A|F 10%,10) - 18,000 + 4.50x

$$x = \frac{-33{,}016}{-4.5} \quad \textbf{7,337 hours per year.}$$

(b) To determine the utilization rate, first calculate the total number of bookable hours (BH) per year.

BH = 2 courts * 14 hours/day/court * 320 days/year
8,960 hours per year

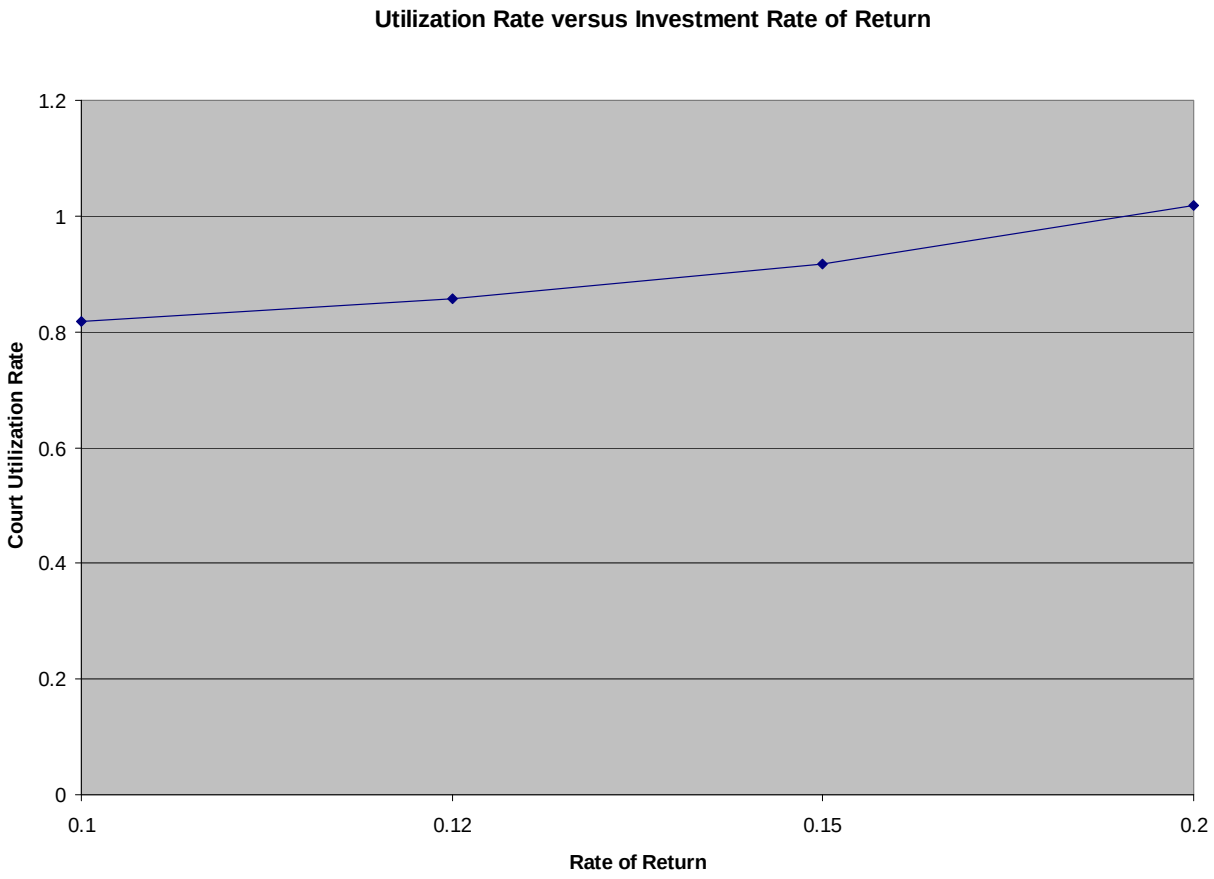
Therefore the answer in (a) represents a utilization rate of:

$$\frac{7{,}337}{8{,}960} \quad 81.88\%$$

To develop the table, use the following data points:

MARR	(A|P i,10)	(A|F i,10)	x	Util. Rate
10%	0.1627	0.0627	7,337	81.88%
12%	0.177	0.0570	7,680	85.71%
15%	0.1993	0.0493	8,210	91.63%
20%	0.2385	0.0385	9,129	101.88%

Question 3 cont'd



Given the high utilization rate required, even at a 10% MARR, this may not be a good investment. The investors would have to decide if both courts can be kept busy at least 82% of the time - 14 hours per day and 320 days per year.

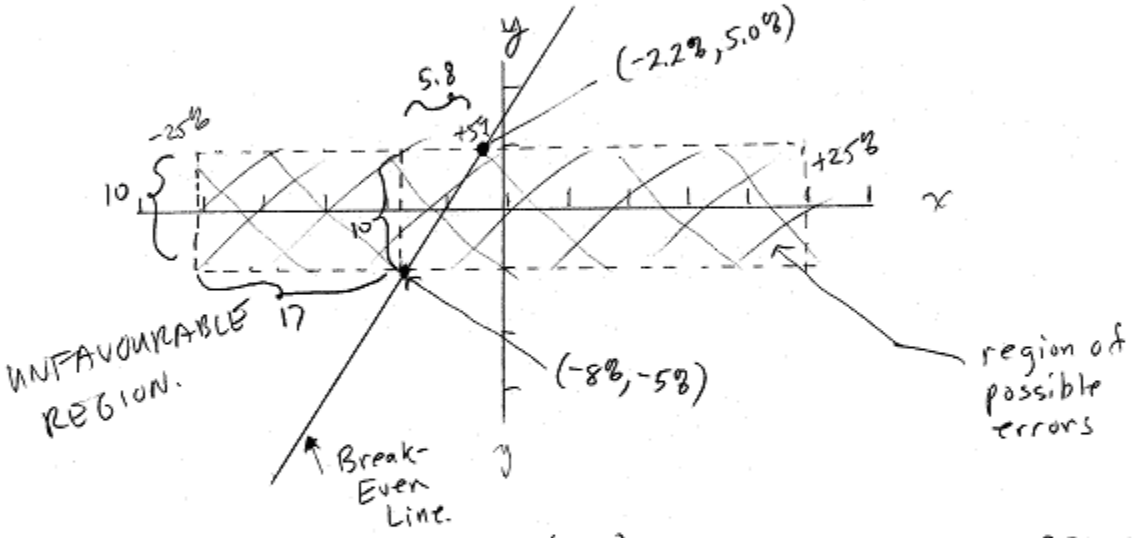
Question 4

PC = 500,000 ; Sales = 200,000 ; Costs = 75,000
MARR = 10% ; Econ Life 6 years.
(P|A 10%,6) = 4.3553

Let x = error in sales estimate
y = error in first cost estimate

then $NPV(x,y) = -500{,}000(1+y) + 200{,}000(P|A\ 10\%,6)(1+x) - 75{,}000\ (P|A\ 10\%,6)$
$= 44{,}413 - 500{,}000\,y + 871{,}060\,x$

Consider the range of errors possible
$-25\% \le x \le +25\%$; $-5\% \le y \le +5\%$



Plot the break-even line $NPV(x,y) = 0 = 44{,}413 - 500{,}000y + 871060x$

$0 = 1.0 - 11.3y + 19.6x$

$\Rightarrow y = +0.0888 + 1.742x$

$\Rightarrow (-2.2\%, 5\%)$; $(-8\%, -5\%)$

Total area of Error Region = $50 \times 10 = 500$

Area of Unfavourability = $10 \times 17 + \frac{1}{2} \times 10 \times 5.8$
$= 199$

% Chance of Unprofitability = $\frac{199}{500} = \boxed{40\%}$