Problem 1) 20 points. Determine the final values of gradea, gradeb and gradec if you were to run the following BOSS program:

```
PROGRAM
  "Final Exam 8-11-04"
DEFINITION
  gradea = 0;
  gradeb = 0;
  gradec = 0;
  LABELS = {goodpaper, badpaper, getac};
CONTROL
  STOPTIME = 5000;
LOGIC
  ARRIVE {TIME = 0 MAX NORMAL(10,1), LIMIT = 800};
  IF CLOCKTIME <= 1000 THEN GOTO goodpaper ELSE GOTO badpaper;
  goodpaper: gradea = gradea + 1;
  DEPART{};
  ARRIVE {TIME = EXPD(50)};
  badpaper: IF RANDOM >= 0.2 THEN GOTO getac;
  gradeb = gradeb + 1;
  getac: gradec = gradec + 1;
  DEPART{};
END.
```

Problem 2) 15 points. I am going to get a rather strange loan. I want to borrow $100000, and the lender wants me to pay it off over 20 years at 6% interest, which if normal. However, he wants me to make payments every two years. In other words, he gives me $100,000 today, then after 2 years I make a payment, and after 4 years I make a payment, and so on until I make the final payment at the end of the 20th year. What will my payment every two years be on this loan?
Problem

MOR/DS 1.00

Date: 8/10/04 Time: 20:36:56
d:\junk\final.bos

MODEL DESCRIPTION
*****************************************************************************

PROGRAM
"Final Exam 8-11-04"

DEFINITION
gradea = 0;
gradeb = 0;
gradec = 0;
LABELS = {goodpaper, badpaper, getac};

CONTROL
STOPTIME=5000;

LOGIC
[ 1] ARRIVE {TIME=0 MAX NORMAL(10,0)};
[ 2] IF CLOCKTIME <= 1000 THEN GOTO goodpaper ELSE GOTO badpaper;
[ 3] goodpaper: gradea = gradea + 1;
[ 4] DEPART{};
[ 5] ;
[ 6] ARRIVE {TIME=50};
[ 7] badpaper: IF RANDOM> 0.2 THEN GOTO getac;
[ 8] gradeb = gradeb + 1;
[ 9] getac: gradec = gradec + 1;
[10] DEPART{};
[12]

Solution with variation removed except for "RANDOM"
Simulation Clock : 5000.00

Block Information

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<tr>
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<th>Line</th>
<th>Label</th>
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<th>Total</th>
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<td>10</td>
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<td>DEPART</td>
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</table>

-------------------------- Global Variables --------------------------

GRADEA  = 100.00
GRADEB  = 90.00
GRADEC  = 499.00
MODEL DESCRIPTION

PROGRAM

"Final Exam 8-11-04"

DEFINITION
gradea = 0;
gradeb = 0;
gradec = 0;
LABELS = {goodpaper, badpaper, getac};

CONTROL
STOPTIME = 5000;

LOGIC

[ 1] ARRIVE {TIME = 0 MAX NORMAL(10,1), LIMIT = 800};
[ 2] IF CLOCKTIME <= 1000 THEN GOTO goodpaper ELSE GOTO badpaper;
[ 3] goodpaper: gradea = gradea + 1;
[ 4] DEPART{};
[ 5]
[ 6] ARRIVE {TIME = EXPD(50)};
[ 7] badpaper: IF RANDOM >= 0.2 THEN GOTO getac;
[ 8] gradeb = gradeb + 1;
[ 9] getac: gradec = gradec + 1;
[10] DEPART{};

Actual Solution
Typical with all randomness included
Simulation Clock : 5000.00

Block Information

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<tr>
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<td>491</td>
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<td>0</td>
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<td>8</td>
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<td>0</td>
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<td>9</td>
<td></td>
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<td>DEPART</td>
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</tbody>
</table>

--------------------------- Global Variables ---------------------------

GRADEA = 99.00
GRADEB = 89.00
GRADEC = 491.00
$A = P(A/P, 69, 20) = 100,000(0.0872) = 8720/yr$

Then $8720$

$F = 8720(1.06) + 8720 = \$17,963.20/2\text{years}$
Problem 3) 30 points. Write a BOSS program to simulate C.E. students coming into the Student Services Office to request forces into CVEN 345 and MEEN 363. Students arrive exponentially distributed about every 5 minutes. 30% of the students request that they be forced into CVEN 345, 50% want MEEN 363, and the remainder want both classes.

It takes an advisor from about 3 to 5 minutes normally distributed to advise a student on each class desired, including the time required to try and force them into each class. There are two advisors in the office and they work from 8:00 am to 5:00 pm, including lunch.

Of the class changes attempted, 30% of the 345 forces and 70% of the 363 force requests will be impossible – i.e. the student will be taking other courses that will make it impossible to force him into the desired class.

Write a BOSS program to simulate this system, keeping track of how many of the requested class changes are successful, how many are unsuccessful, and how many total students (if any) will be told to leave when the office closes at 5:00 pm, without having been completed with their force requests. If any data that you think is needed to solve this problem is not stated above, make an appropriate assumption, and state that assumption clearly in your solution.

Problem 4) 10 points. I just took out a 100,000, 6%, 10 year, interest only loan. At the end of 10 years, what will my final payment be?

Monthly payments assumed:  
\[ F = \$100,000 + \$100,000 \left( \frac{0.06}{12} \right) \]
\[ = \$100,500 \]

Yearly payments assumed:  
\[ F = \$100,000 + \$100,000 \times 0.06 \]
\[ = \$106,000 \]

\[ P = \$100,000 \]

Use "A" for answer.
Problem 3

"Final Exam Student Advising Problem 3 - 8-11-04"

DEFINITION
    number1 = 0;
    successful = 0;
    unsuccessful = 0;
    totalstudents = 0;
    LABELS = {cven345, meen363, both};
    advisor: RESOURCE={CAPACITY=2};

CONTROL
    STOPTIME = 9*60;

LOGIC
    ARRIVE {TIME = EXPD(5)};
    totalstudents = totalstudents+1; "Tally the total number of students
    who come for advising"
    number1 = RANDOM; "cast a random number to see what the student wants"
    IF number1 <= 0.3 THEN GOTO cven345; "Send 30% to ask for 345"
    IF number1 <= 0.8 THEN GOTO meen363; "send 50% to ask for 363"
    GOTO both; "send all the rest to ask for both"

    cven345: SEIZE{NAME=advisor};
    WAIT{TIME = 0 MAX NORMAL(4,1/3)};
    IF RANDOM <= 0.7 then successful = successful+1 ELSE unsuccessful =
    unsuccessful+1;
    RELEASE{NAME = advisor};
    DEPART;

    meen363: SEIZE{NAME=advisor};
    WAIT{TIME = 0 MAX NORMAL(4,1/3)};
    IF RANDOM <= 0.3 then successful = successful+1 ELSE unsuccessful =
    unsuccessful+1;
    RELEASE{NAME = advisor};
    DEPART;

    both: SEIZE{NAME=advisor};
    WAIT{TIME = 0 MAX NORMAL(4,1/3)}; "see advisor and ask for 345"
    IF RANDOM <= 0.7 then successful = successful+1 ELSE unsuccessful =
    unsuccessful+1;
    WAIT{TIME = 0 MAX NORMAL(4,1/3)}; "now ask about 363"
    IF RANDOM <= 0.3 then successful = successful+1 ELSE unsuccessful =
    unsuccessful+1;
    RELEASE{NAME = advisor};
    DEPART;

END.
Problem 5) 25 points. I have been asked to specify a backfill mix to be used in the reconstruction and repair of a recently collapsed steel shell aqueduct. It has been alleged that the structure failed due to improper backfill material, which did not meet the following specifications:

<table>
<thead>
<tr>
<th>Material Classification</th>
<th>Material Description</th>
<th>Minimum Required</th>
<th>Maximum Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Clean gravel over 2”</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>B</td>
<td>Clean gravel from ½” to 2”</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td>C</td>
<td>Clean sand</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>D</td>
<td>Silt</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Clay</td>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

I have access to the following sources of materials, which are composed of the quantities listed. It is not possible to screen or otherwise modify the compositions listed below. If you want a truckload of material from any of these sources, they will consist of the quantities shown, and you will have to use them as they come from the pit. It is possible to mix and blend any amounts from the sources to get what you need. For example, if you get material from the Austin pit, you will find that every truck brings to your job site 60% clean gravel over 2”, 20% clean gravel from ½” to 2”, and 20% clean sand, with no silt.

<table>
<thead>
<tr>
<th>Material Classification</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Cost/cy</th>
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</thead>
<tbody>
<tr>
<td>Austin pit</td>
<td>60%</td>
<td>20%</td>
<td>20%</td>
<td>0%</td>
<td>$12</td>
</tr>
<tr>
<td>Baytown pit</td>
<td>20%</td>
<td>69%</td>
<td>10%</td>
<td>1%</td>
<td>$14</td>
</tr>
<tr>
<td>Georgetown pit</td>
<td>17%</td>
<td>12%</td>
<td>70%</td>
<td>1%</td>
<td>$8</td>
</tr>
<tr>
<td>Hearne pit</td>
<td>30%</td>
<td>30%</td>
<td>40%</td>
<td>0%</td>
<td>$20</td>
</tr>
</tbody>
</table>

Write an LP program to determine the least expensive way of obtaining these materials.

300,000 cy needed
"Backfill final exam problem 8-11-04"
Min Z = 12A+14B+8G+20H
ST 0.60A+0.20B+0.17G+0.30H-0.20(A+B+G+H) >= 0
     0.60A+0.20B+0.17G+0.30H-0.30(A+B+G+H) <= 0
     0.20A+0.69B+0.12G+0.30H-0.30(A+B+G+H) >= 0
     0.20A+0.69B+0.12G+0.30H-0.50(A+B+G+H) <= 0
     0.20A+0.10B+0.70G+0.40H-0.40(A+B+G+H) >= 0
     0.20A+0.10B+0.70G+0.40H-0.50(A+B+G+H) <= 0
     0.00A+0.01B+0.01G+0.00H-0.02(A+B+G+H) >= 0
     A+B+G+H >= 30000

"Check quantities received:"
TOTAL - (A+B+G+H) = 0
GRAVELOVER2 - (0.60A+0.20B+0.17G+0.30H) = 0
GRAVELOVERHALF - (0.20A+0.10B+0.12G+0.30H) = 0
SAND - (0.19A+0.10B+0.70G+0.40H) = 0
SILT - (0.00A+0.01B+0.01G+0.00H) = 0

"Check min allowed:"
ingravelover2 - 0.20(A+B+G+H) = 0
mingraveloverhalf - 0.30(A+B+G+H) = 0
minsand - 0.4(A+B+G+H) = 0

"Check max allowed:"
maxgravelover2 - 0.30*(A+B+G+H) = 0
maxgraveloverhalf - 0.50(A+B+G+H) = 0
maxsand - 0.5(A+B+G+H) = 0
maxsilt - 0.02(A+B+G+H) = 0

^^^^ Optimal Solution ^^^

Z   =  301409.1467
A   =  1446.2299
B   =  9270.7046
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<th>Value</th>
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<td>H</td>
<td>0.0000</td>
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<tr>
<td>TOTAL</td>
<td>30000.0000</td>
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<tr>
<td>GRAVELOVER2</td>
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</tr>
<tr>
<td>GRAVELOVERHALF</td>
<td>8907.2930</td>
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<tr>
<td>SAND</td>
<td>14700.0000</td>
</tr>
<tr>
<td>SILT</td>
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<tr>
<td>MINGRAVELOVER2</td>
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<td>MINGRAVELOVERHA</td>
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Compile time: 0.05 (Secs.)
Run time : 0.00 (Secs.)