General examination rules:

1) Do not put your completed work on a desk or on the floor next to you or anywhere it can be seen by others. If any part of your work can be seen by others it will be confiscated and you will not be permitted to rework those problems. Place it face down on your desk under your existing work.

2) Please remove your hat. If it is part of your head, turn it around backwards.

3) Please believe this: if your work not legible, or if I cannot follow your logic at a glance, or if you use a #9 nail for a pencil with 2 point font, it will receive no credit. This paper will be written to acceptable engineering standards or it will receive no credit.

4) Each problem has the same value.

5) You may work on your own paper or you may use paper supplied at the front of the room.

6) Please read the problem very carefully. Giving me the correct answer to something I didn’t ask is worth zero points.

Ethical Standards:

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System.

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this exam."

______________________________________________________
Signature of student

Please do not open this exam until you are told to do so.
Problem 1) I will be borrowing $180,000 from the bank to buy a new house. They have offered me a 3% loan for 30 years. After 10 years I won the lottery and paid off the loan. How much did it cost me to pay off the loan?

Problem 2) A farmer is deciding whether to plant rice, soybeans, or wheat, and in which field. The cost to plant an acre of grain = $50/acre for rice, $30/acre for soybeans, and $40/acre for wheat. Profit from the crop will be $18/bushel for rice, $12/bushel for soybeans, and $10/bushel for wheat. Yields vary depending on what crop is planted in which field as follows:

<table>
<thead>
<tr>
<th>Field</th>
<th>Rice</th>
<th>Soybeans</th>
<th>Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>300 bushels/acre</td>
<td>100 bushels/acre</td>
<td>500 bushels/acre</td>
</tr>
<tr>
<td>B</td>
<td>Won’t grow</td>
<td>150 bushels/acre</td>
<td>200 bushels/acre</td>
</tr>
<tr>
<td>C</td>
<td>200 bushels/acre</td>
<td>200 bushels/acre</td>
<td>600 bushels/acre</td>
</tr>
<tr>
<td>D</td>
<td>400 bushels/acre</td>
<td>400 bushels/acre</td>
<td>300 bushels/acre</td>
</tr>
</tbody>
</table>

Because of the equipment used for planting, only one type of grain can be planted in each field. Also, because of the pesticides used, wheat cannot be planted in a field adjacent to rice. Finally, market conditions require that you plant no more than 150 acres of wheat. Our fields are positioned as shown below. Write an LP solution to determine what the farmer should plant and how much he will make.

<table>
<thead>
<tr>
<th>Field A</th>
<th>100 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field B</td>
<td>40 acres</td>
</tr>
<tr>
<td>Field C</td>
<td>60 acres</td>
</tr>
<tr>
<td>Field D</td>
<td>50 acres</td>
</tr>
</tbody>
</table>

Problem 3) An electronic manufacturer is considering two methods for producing circuit boards for the next 9 years. The board can be hand wired at a cost of $1.20 per unit, in addition to an annual equipment cost of $300. The circuit board can also be produced with an investment of $4,500 in printed circuit processing equipment that will have an expected life of 9 years and a salvage value of $150. In this case, labor costs will be $0.52 per unit and the maintenance cost for the equipment will be $150 per year. If the interest rate is 10%, how many circuit boards must be produced each year for the two methods to break even?
Problem 4) You have been asked to write a BOSS program to determine how often a drilling platform will have to be repaired due to abrasion from ice flow impact. The platform is supported by a single pile, 60” outside diameter with a 2” wall. Ice flow in and out of the Bering Sea causes abrasion on the north and south sides of the pile from tidal currents.

North side: Ice impacts the platform about every 1 hour, distributed normally with a sigma of 5 minutes. When the ice hits the north side of the pile it abrades the pile for about 10 minutes normally distributed with a sigma of 3 minutes. The force on the pile from the ice averages 1000 kN, distributed exponentially, with a maximum abrading force of 2000 kN.

South side: Ice impacts the platform about every 2 hours, distributed normally with a sigma of 15 minutes. When the ice hits the south side of the pile it abrades the pile for about 10 minutes normally distributed with a sigma of 3 minutes. The force on the pile from the ice averages 500 kN, distributed exponentially, with a maximum abrading force of 2000 kN.

Impacting ice abrades the pile at a rate of 0.005” per kN minute. The pile wall can safely withstand abrasion down to a thickness of 1.0”, after which a 1” thick steel patch must be welded on the weakened side of the pile at a cost of $60,000.

Write a BOSS program to predict how often the platform will need repair, and at what cost, per year.

Problem 5) I have been told that Room 118 will not be available for use during our final exam, and that we will have to use Room 003 instead. That room has 20 seats. Since we won’t all fit in that room I have told all of my 322 students that they can come at any time starting at 8:00 am. Knowing my students, I calculate that they will come exponentially distributed with a mean of 15 minutes. The quiz is designed to take them a mean of 1 hour to work, normally distributed, with a sigma of 10 minutes. Write a BOSS program to see how often students will have to wait for a seat to become available to take the exam. There are 35 students in the class.
\[ A = 180,000 \]

\[ \frac{180,000}{237,193422} = \frac{1,456,892}{100,6192} = 237,193422 \]

\[ A = 180,000 \]

\[ \frac{A}{237,193422} = \frac{1,456,892}{100,6192} = \sqrt{758,187433} \]

\[ n = 10 \times 12 = 120 \]

\[ A = 758,874333 \]

\[ (P/A, 14\%, 120) + F\left(\frac{P/F}{14\%, 120}\right) \]

\[ (P/A, 14\%, 120) = \frac{(1 + 0.025)^{120} - 1}{0.025(1 + 0.025)^{120}} = \frac{34985.9}{0.025(1 + 0.025)^{120}} = 103,573,673 \]

\[ (P/F, 14\%, 120) = (1 + 0.025)^{-120} = 0.791926 \]

\[ 180,000 = 758,874333 (103,573,673) + F(0.791926) \]

\[ F = \$136,825,185,922 \]

Will cost me \$136,825,185,922 to pay the loan off after 10 years.
VARIABLES: RA = 0,1 - IMFIIIMBEI TO PLANT RICE IN FIELD A (YES OR NO)
RA, SA, WA, RB, SB, WB, RC, SC, WC, RD, SD, WD

MAX Z = (18*300*100 - 50*100)RA + (18*0*100 - 50*100)RB + ...
+ ..... + (10*500*100 - 40*100)WA + ... +(10*300*50 - 40*50)WD
PROFITS AND COSTS OF EACH GRAIN IN EACH FIELD

ST RA+SA+WA <= 1 MAKES SURE YOU ONLY TRY AND PLANT ONE TYPE OF GRAIN IN EACH FIELD
CANNOT BE = 1, SINCE THAT WOULD MAKE YOU PLANT SOMETHING IN EACH FIELD
EVEN IF THAT MADE YOU LOSE MONEY ON THE FIELD. IF THE
FIELD CAN'T GROW A PROFIT, YOU SHOULD NOT PLANT IT.

RB+SB+WB <= 1
RC+SC+WC <= 1
RD+SD+WD <= 1

WA+RB <= 1 MAKES SURE YOU DON'T PLANT WHEAT IN FIELD A NEXT TO RICE IN FIELD B
WA+RC <= 1 MAKES SURE YOU DON'T PLANT WHEAT IN FIELD A NEXT TO RICE IN FIELD C
WB+RA <= 1; WB+RC <= 1; WB+RD <= 1;
WC+RA <= 1; WC+RB <= 1; WC+RD <= 1;
WD+RB <= 1; WD+RC <= 1;

100WA + 40WB + 60WC + 50WD <= 150 MAKES SURE YOU DON'T PLANT MORE THAN 150 ACRES OF WHEAT
Option 1:
- 9 Years Life
- Cost $1.20 Per Unit
- Cost 300 Per Year

Option 2:
- Initial Investment = $9,500
- 9 Years Life
- S = 150
- Cost 0.52 Per Unit
- Cost 150 Per Year

\[ \text{\( C = 10\% \)} \]

\[ \text{One} \]

\[ \text{Two} \]

\[ 1.20w \left( \frac{1}{10}, 1, 9 \right) + 300 \left( \frac{1}{10}, 1, 9 \right) = 4500 + 0.52w \left( \frac{1}{10}, 1, 9 \right) + 150 \left( \frac{1}{10}, 1, 9 \right) - 150 \left( \frac{1}{10}, 1, 9 \right) \]

\[ \left( \frac{1}{10}, 1, 9 \right) = 5.7590 \]

\[ \left( \frac{1}{10}, 1, 9 \right) = 1.924 \]

\[ 1.20w \left( 5.7590 \right) + 300 \left( 5.7590 \right) = 4500 + 0.52w \left( 5.7590 \right) + 150 \left( 5.7590 \right) - 150 \left( 1.924 \right) \]

\[ 6.9108w + 1727.88 = 4500 + 2.9948w + 863.85 - 63.615 \]

\[ 6.9108w - 2.9948w = 4500 + 863.85 - 63.615 - 1727.88 \]

\[ w = \frac{3572.355}{3.91120} \]

\[ w = 912.217961 \]

\[ 912.217961 \text{ Units need to be produced per year to break even} \]
PROGRAM
"ice impact"

DEFINITION
nthick = 2.0; "original thickness of north side of pile"
ntime = 0.0; "time of impact on north face"
nforce = 0.0; "force on north side of pile"
nwear = 0.0; "wear on north side of pile"
ncost = 0.0; "cost for north side repairs"

stthick = 2.0; "original thickness of south side of pile"
stime = 0.0; "time of impact on south face"
sforce = 0.0; "force on south side of pile"
swear = 0.0; "wear on south side of pile"
sccost = 0.0; "cost for south side repairs"

LABELS={pileok};

CONTROL
STOPTIME=365*24*60; "study costs for a year"

LOGIC
ARRIVE {TIME=0 MAX NORMAL(60,5)}; "ARRIVE NORTH ICE SHEET"
nctime = 0 MAX NORMAL(10,3); "calculate time ice hits platform on north side"
nforce = EXPD(1000); "calculate force on north side"
IF nforce >= 2000 THEN nforce = 2000; "Limit force on north side to 2000"
nwear = 0.005*ntime*nforce; "Calculate wear on north side of platform"
nthick = nthick - nwear; "Calculate new thickness of pile"
IF nthick >= 1.0 THEN GOTO pileok; "pile wear within acceptable limits"
ncost = ncost + 60000; "add repair cost to north side of pile"
nthick = nthick + 1.0; "add 1 inch plate to north side of pile"
pileok: DEPART{}; "north ice sheet leaves area"

ARRIVE {TIME=0 MAX NORMAL(120,15)}; "ARRIVE SOUTH ICE SHEET"
stime = 0 MAX NORMAL(10,3); "calculate time ice hits platform on south side"
sforce = EXPD(500); "calculate force on south side"
IF sforce >= 2000 THEN sforce = 2000; "Limit force on south side to 2000"
swear = 0.005*stime*sforce; "Calculate wear on south side of platform"
sthick = stthick - swear; "Calculate new thickness of pile"
IF stthick >= 1.0 THEN GOTO pileok; "pile wear within acceptable limits"
scost = scost + 60000; "add repair cost to south side of pile"
sthick = stthick + 1.0; "add 1 inch plate to south side of pile"
DEPART{}; "south ice sheet leaves area"

END.
PROGRAM

"exam given in small classroom"

DEFINITION

seat:RESOURCE = {CAPACITY = 20}; "make room for 20 students"
linegotthisbig = 0; "keep track of how big the line outside the room got"
standinginline = 0; "how many are currently in the queue"

CONTROL

STOPTIME=12*60; "let them come for 12 hours (in minutes)"
WATCHLIST = {seat};

LOGIC

ARRIVE {TIME=EXPD(15), LIMIT=35};
SEIZE {NAME = seat};
standinginline = USED[seat:QUEUE];
IF standinginline >= linegotthisbig THEN linegotthisbig = standinginline;
WAIT {TIME = 0 MAX NORMAL(60,10)};
RELEASE {NAME = seat};
DEPART{ };

END.
PROGRAM
"Classroom Simulation"

DEFINITION
Seat: RESOURCE = \$CAPACITY=20\$
LABELS = &take test, have to wait, go home

studentsWhoWaited = 0

CONTROL
RANDOMIZE-ON
STOPTIME = 8*60

LOGIC

ARRIVE\{TIME=EXPO(15), LIMIT=35\} "Bums students"

SEIZE\{NAME=seat, REXCESS=have to wait, take seat if possible"

take test:

WAIT\{TIME=0 MAX NORMAL(60 10)\} "take the test"

RELEASE\{NAME=seat \$5, "Love the class"

GOTO go home\$

wait at wait:

studentsWhoWaited = studentsWhoWaited + 1 $5 "Keeps track of the number of students who waited"

SEIZE\{NAME=seat, 55 "take seat"

GOTO take test

go home:

DEPART\$3

END.