OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE **4773**

Decision Mathematics Computation

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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1.

(i)	$u_n = 1.05u_{n-1} - 60$	M1 A2
(ii)	$u_n = 1000\times1.05^n - 60\dfrac{\left(1.05^n - 1\right)}{0.05}$ $= 1200 - 200\times1.05^n$ or $u_n = \lambda 1.05^n + \mu$ $1000 = \lambda + \mu$ $990 = 1.05\lambda + \mu$, etc	M1 A2 A1
(iii)	int(log(6)/log(1.05)) = 36 years (or spreadsheet)	M1 A1
(iv)	1000 1025 990.625 1015.391 980.7754 1005.295 etc.	M1 A1 A1
(v)	37 years (+ 6 months OK)	B1 cao
(vi)	1000 970 989.25 959.25 977.9625 947.9625 etc.	M1 A1 A1 interest OK A1
(vii)	35 years	B1 cao

2.

(i) $5\sqrt{2}$ — B1

(ii) e.g. (negatives of these OK)

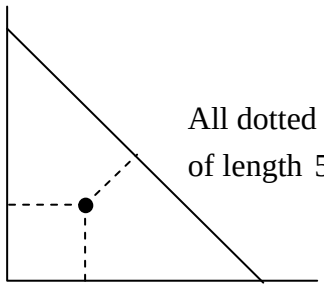
```
min  m
st   p-m<0
     -p-m<0
     q-m<0
     -q-m<0
     -p-q-1.414214m<-10
     p+q-1.414214m<10
end
```

M1 first 2 pairs
A1 first pair
A1 second pair
A1 last pair

(iii)

```
Objective value:  2.928932
Variable     Value              Reduced Cost
M            2.928932           0.000000
P            2.928932           0.000000
Q            2.928932           0.000000
```

B1



All dotted lines are of length $5\left(2-\sqrt{2}\right)$

M1 drawing
A1 lines
A1 point
B1 equidistant

(iv) e.g.

```
min  m
st   q-m<0
     -q-m<0
     p+q-1.414214m<1
     -p-q-1.414214m<-1
     p-q-1.414214m<-1
     -p+q-1.414214m<1
end
```

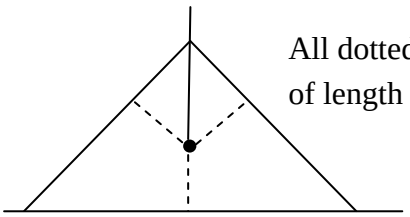
M1
A1 first pair
A1 second pair
A1 third pair

(v)

```
Objective value:  0.4142135
Variable   Value              Reduced Cost
M          0.4142135          0.000000
Q          0.4142135          0.000000
P          0.000000           0.000000
```

B1

(vi)



All dotted lines are of length $\sqrt{2}-1$

B1 lines
B1 point
B1 distances

3.

(i)
```
Min  2x11+3x12+7x13+x21+8x22+4x23
st   x11+x12+x13=10
     x21+x22+x23=10
     x11+x21<7
     x12+x22<7
     x13+x23<7
end
```

B1
B1 supplies

B1 depots

(ii)
```
Objective value:  55.00000
Variable   Value                Reduced Cost
X11        3.000000             0.000000
X12        7.000000             0.000000
X13        0.000000             3.000000
X21        4.000000             0.000000
X22        0.000000             6.000000
X23        6.000000             0.000000
```

B1

3 containers from S1 to D1
7 containers from S1 to D2
4 containers from S2 to D1
6 containers from S2 to D3
total cost = 55

B1 logistics
B1 cost

(iii)
```
Min  2y11+3y12+9y13+y14+4y21+7y22+2y23
     +5y24+y31+5y32+3y33+6y34
st   y11+y12+y13+y14=7
     y21+y22+y23+y24=7
     y31+y32+y33+y34=6
     y11+y21+y31=7
     y12+y22+y32=4
     y13+y23+y33=6
     y14+y24+y34=3
end
```

B1

B1 depots

B1 demands

(iv)
```
Objective value:  37.00000
Variable   Value                Reduced Cost
Y11        0.000000             2.000000
Y12        4.000000             0.000000
Y13        0.000000             11.00000
Y14        3.000000             0.000000
Y21        1.000000             0.000000
Y22        0.000000             0.000000
Y23        6.000000             0.000000
Y24        0.000000             0.000000
Y31        6.000000             0.000000
Y32        0.000000             1.000000
Y33        0.000000             4.000000
Y34        0.000000             4.000000
```

B1

4 containers from D1 to C2
3 containers from D1 to C4
1 container from D2 to C1
6 containers from D2 to C3
6 containers from D3 to C1
total cost = 37

B1 logistics + cost

(v)

```
min  2x11+3x12+7x13+x21+8x22+4x23+2y11+3y12
     +9y13+y14+4y21+7y22+2y23+5y24+y31+5y32
     +3y33+6y34
st   x11+x12+x13=10
     x21+x22+x23=10
     y11+y21+y31=7
     y12+y22+y32=4
     y13+y23+y33=6
     y14+y24+y34=3
     x11+x21<7
     x12+x22<7
     x13+x23<7
     y11+y12+y13+y14-x11-x21=0
     y21+y22+y23+y24–x12–x22=0
     y31+y32+y33+y34-x13-x23=0
end
```

B1

B1 supplies

B1 demands + depots

B1 trans-shipment

(vi)

```
Objective value:  91.00000
```

Variable	Value	Reduced Cost
X11	4.000000	0.000000
X12	6.000000	0.000000
X13	0.000000	2.000000
X21	3.000000	0.000000
X22	0.000000	6.000000
X23	7.000000	0.000000
Y11	0.000000	0.000000
Y12	4.000000	0.000000
Y13	0.000000	8.000000
Y14	3.000000	0.000000
Y21	0.000000	1.000000
Y22	0.000000	3.000000
Y23	6.000000	0.000000
Y24	0.000000	3.000000
Y31	7.000000	0.000000
Y32	0.000000	3.000000
Y33	0.000000	3.000000
Y34	0.000000	6.000000

B1

4 containers from S1 to D1
6 containers from S1 to D2
3 containers from S2 to D1
7 containers from S2 to D3
4 containers from D1 to C2
3 containers from D1 to C4
6 containers from D2 to C3
7 containers from D3 to C1
total cost = 91

B1

Suboptimising does not give the optimum

B1 cao

4.

(i)	e.g. = lookup(rand(),A1:A3,B1:B3) with A B 1 0 0 2 0.1 1 3 0.6 2	M1 A1 B1 B1
(ii)	Many approaches possible, but all must allow for 3 applications of part (i) Offspring from generation 0 Conditional offspring from generation 1(s) Output	 B2 B1 B1 M1A1 M1A1 B1
(iii)	Theoretical probabilities (Galton-Watson branching): 0 1 2 3 4 0.154 0.29 0.332 0.16 0.064	 M1 A1
(iv)	Two independent runs. Sum the numbers in the two second generations. (or nested "IF"s) 0, 1, 2, 3, 4, 5, 6, 7, 8	B1 B1 (M1 A1) B1

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