Indirect Method:	
Maximisation method	Minimisation method
In the form of	In the form of
maximise C ^T x	minimise b ^T y
subject to Ax ≤ b	subject to $A^{T}y \geq c$
X E [R.+	y EIR#
· replacing ='s with 21's</td <td>· replacing ='s with <!--2's</td--></td>	· replacing ='s with 2's</td
· replacing >'s with <'s	· Yeplacing >'s with <'s
replacing unrestricted variables	· replacing unvestricted variables
with restricted ones	with restricted ones
Example:	
minimise 3x-y	
Subject to $2x+y=5$	
x>0, Y E R	
D. Replace '=' Constraints	
subject to 2x+y <5	minimise 3x-y++y~ Subject to 2x+y+-y=5 > Standard form
2×+7 =5 ->-2×-7 <-5	$\begin{array}{c} -2x - y + + y \ge -5 \\ \times \cdot y + \cdot y^- \ge 0 \end{array} \qquad \begin{array}{c} b = \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix}, C = \begin{pmatrix} 5 \\ -5 \end{pmatrix}$
	$A^{T} = \begin{pmatrix} 2 & 1 & -1 \\ -2 & -1 & 1 \end{pmatrix}$
S. Duol form:	
Moramise $5x_1 - 5x_2$	
subject to $2x_1 - 2x_2 \le 3$	
X ₁ -X ₂ ≤ -	
-1/1/2 5/	
X1, X2 ≥ D	

Erample:
minimise 3x, 45x2-x3
subject to $x_1+x_3=4$
X2-24362
Y, r, r, 20, r, unrestricted
minimise 3x, + 5x2- x3+ x8=
x1+(+3-+5) > 4
- K1 - (K3+- K8-) =-4
$- x_{2} + 2 + 3 \ge -2 \longrightarrow - x_{2} + 2 (x_{3}^{+} - x_{3}^{-}) \ge -2$
\(\frac{1}{1}, \frac{1}{1}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2} \)
minimise 34+5x2- x3++x3)
$\chi_1 + \chi_3^+ - \chi_3^- \ge 4$ Standard form
$- x_{1} - x_{3}^{+} + x_{3}^{-} \ge -4$ $- x_{2}^{+} + 2x_{2}^{+} - 2x_{2}^{-} \ge -2$ $- x_{3}^{+} + 2x_{3}^{+} - 2x_{2}^{-} \ge -2$ $- x_{3}^{+} + 2x_{3}^{+} - 2x_{2}^{-} \ge -2$
4, 72, 12t, 13-20 AT = [- 0 - 1]
0 -1 2 -2 /
Dual form:
maximise $44,-44z-243$
Subject to 1,-12 = 3
-13 \(5 \)
11- 12t 2/3 E-1
-\frac{1}{1} + \frac{1}{2} - \frac{1}{3} \le \frac{1}{2}
1.1.13 > 0

Direct Method:				
	1 Corre	espondence variables <	⇔ constraints:	
Example:	• F	for every <i>primal constrai</i> for every <i>primal variable</i>	 <mark>nt</mark> , create a <i>dual variat</i>	
	2 Cons	straint matrix, objective	function and right-ha	and sides:
minimise 3x-y		ranspose the <i>primal cor</i> he <i>dual constraint matrix</i>		
Subject to $2x+y=5$	• T	The primal objective coet dual right-hand side coet	fficients c become the	
x≥0, y ∈ R		he primal right-hand sid dual objective coefficient		ne the
One constraint, two decision variables	for s	onima)		
one decision variable, two constraints	for	dual		
	1	Cross		
	Obje	ctive & constraint dire	ections, variable ran	ges:
moraimise 5Z		ctive & constraint dire e primal problem is a n		_
	If the	e primal problem is a <i>n</i> The dual problem is a <i>n</i>	maximisation problem	:
moraimise $5Z$ Subject to $2Z \leq 3$	If the	e primal problem is a number of the dual problem is a number in the primal constraint	naximisation problem ninimisation problem. i-th dual variable	:
	If the	e primal problem is a <i>n</i> The dual problem is a <i>n</i>	naximisation problem minimisation problem.	:
Subject to 22 ≤ 3 12 = 1	If the	e primal problem is a rather the dual problem is a rather than the dual p	naximisation problem ninimisation problem. i-th dual variable $y_i \ge 0$ y_i unrestricted	("sensible") ("odd")
Subject to 2Z ≤ 3	If the	e primal problem is a number of the dual problem is a number	naximisation problem ninimisation problem. i-th dual variable $y_i \ge 0$ y_i unrestricted $y_i \le 0$ i-th dual constraint $a_i^T \mathbf{y} \ge c_i$	("sensible") ("odd") ("bizarre") ("sensible")
Subject to 22 ≤ 3 12 = 1	If the	e primal problem is a n . The dual problem is a n i-th primal constraint $a_i^{T} \mathbf{x} \leq b_i$ $a_i^{T} \mathbf{x} = b_i$ $a_i^{T} \mathbf{x} \geq b_i$ i-th primal $variable$	naximisation problem ninimisation problem. i-th dual variable $y_i \ge 0$ y_i unrestricted $y_i \le 0$ i-th dual constraint	("sensible") ("odd") ("bizarre")
Subject to 22 ≤ 3 12 = 1	If the	e primal problem is a n . The dual problem is a n . The dual problem is a n . The dual problem is a n . The primal constraint $a_i^{T} \mathbf{x} \leq b_i$ $a_i^{T} \mathbf{x} = b_i$ $a_i^{T} \mathbf{x} \geq b_i$ i. The primal variable $x_i \geq 0$ $x_i \text{ unrestricted}$	maximisation problem inimisation problem. i-th dual variable $y_i \ge 0$ y unrestricted $y_i \le 0$ i-th dual constraint $a_i^T \mathbf{y} \ge c_i$ $a_i^T \mathbf{y} = c_i$	("sensible") ("odd") ("bizarre") ("sensible") ("odd")
Subject to 22 ≤ 3 12 = 1	If the	e primal problem is a n . The dual problem is a n . The dual problem is a n . The dual problem is a n . The primal constraint $a_i^{T} \mathbf{x} \leq b_i$ $a_i^{T} \mathbf{x} = b_i$ $a_i^{T} \mathbf{x} \geq b_i$ i. The primal variable $x_i \geq 0$ $x_i \text{ unrestricted}$	maximisation problem inimisation problem. i-th dual variable $y_i \ge 0$ y unrestricted $y_i \le 0$ i-th dual constraint $a_i^T \mathbf{y} \ge c_i$ $a_i^T \mathbf{y} = c_i$	("sensible") ("odd") ("bizarre") ("sensible") ("odd")
Subject to 22 ≤ 3 12 = 1	If the	e primal problem is a n . The dual problem is a n . The dual problem is a n . The dual problem is a n . The primal constraint $a_i^T \mathbf{x} \le b_i$ $a_i^T \mathbf{x} = b_i$ $a_i^T \mathbf{x} \ge b_i$. The primal variable $x_i \ge 0$ x_i unrestricted $x_i \le 0$.	maximisation problem. i-th dual variable $y_i \ge 0$ y _i unrestricted $y_i \le 0$ i-th dual constraint $a_i^{T} \mathbf{y} \ge c_i$ $a_i^{T} \mathbf{y} \le c_j$ ections, variable ran	("sensible") ("odd") ("bizarre") ("sensible") ("odd") ("bizarre")
Subject to 22 ≤ 3 12 = 1	If the	e primal problem is a reference primal problem is a reference and problem is a reference at the distribution of the dual problem is a reference at the distribution of the dual problem is a reference at the distribution of the dual problem is a reference at the distribution of the dual problem is a reference at the distribution of the dual problem is a reference at the distribution of the dual problem is a reference at the dual prob	naximisation problem. i-th dual variable $y_i \ge 0$ y_i unrestricted $y_i \le 0$ i-th dual constraint $a_i^{T} \mathbf{y} \ge c_i$ $a_i^{T} \mathbf{y} \le c_j$ ections, variable raminimisation problem:	("sensible") ("odd") ("bizarre") ("sensible") ("odd") ("bizarre")
Subject to 22 ≤ 3 12 = 1	If the	e primal problem is a refine dual problem is	naximisation problem. i-th dual variable y _i ≥ 0 y _i unrestricted y _i ≤ 0 i-th dual constraint a _i ^T y ≥ c _i a _i ^T y = c _i a _i ^T y ≤ c _i ections, variable ran minimisation problem: maximisation problem:	("sensible") ("odd") ("bizarre") ("sensible") ("odd") ("bizarre")
Subject to 22 ≤ 3 12 = 1	If the	e primal problem is a refine dual problem is	naximisation problem. i-th dual variable $y_i \ge 0$ y_i unrestricted $y_i \le 0$ i-th dual constraint $a_i^{T} \mathbf{y} \ge c_i$ $a_i^{T} \mathbf{y} = c_i$ $a_i^{T} \mathbf{y} \le c_i$ ections, variable ran minimisation problem: i-th dual variable $y_i \ge 0$	("sensible") ("odd") ("bizarre") ("sensible") ("odd") ("bizarre")
Subject to 22 ≤ 3 12 = 1	If the	e primal problem is a refine dual problem is	naximisation problem. i-th dual variable $y_i \ge 0$ y_i unrestricted $y_i \le 0$ i-th dual constraint $a_i^{T} \mathbf{y} \ge c_i$ $a_i^{T} \mathbf{y} = c_i$ $a_i^{T} \mathbf{y} \le c_i$ ections, variable raminimisation problem: maximisation problem: i-th dual variable	("sensible") ("odd") ("bizarre") ("sensible") ("odd") ("bizarre")

("sensible") ("odd") ("bizarre")

 $a_j^\mathsf{T} \mathbf{y} \le C_j$ $a_j^\mathsf{T} \mathbf{y} = C_j$ $a_j^\mathsf{T} \mathbf{y} \ge C_j$

 $x_i \ge 0$ x_i unrestricted $x_i \le 0$

Example:	
matimise x1-x3	three decision variobles (primal)
s.t. 1111=4	two constraints
T [0 \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	J.
$A = \begin{bmatrix} 1 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$ $X_1, X_2 \leq 0$. $X_3 \leq 2$	two decision variables (dual)
	throe constraints
minimise 4 /, +2 /2	
5t. 1	
<u> </u>	
12 = -	
Y1 unvestricted. 1220 minimi	ise 4/1+2/2
subject	to fiel
	Y1 < 0
	\r_\
	1, currestricted, 1220

Duality Theorem

Diality Theorem

Dialit

19. A duel price is reported for each constraint.

The duel price is only positive when a constraint is binding. D. The duel price gives the improvement in the objective function is relaxed by one unit.
O. The duel price gives the improvement in the objective function
is relaxed by one unit-