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**HP 41C PROGRAM SUBMITTAL FORM**  
**PROGRAMMFORMBLATT/DOCUMENTATION DU PROGRAMME/GENERALITÀ SUL PROGRAMMA**

<b>Program Title</b> Programmtitel Titre du programme Titolo del programma	<u>LINEAR PROGRAMMING (SIMPLEX METHOD) II</u>		
<b>Category No.</b> Kategorie Nr. Catégorie N° Categoria N°	<u>009</u>	<b>Name</b> Rubrik Rubrique Nome della categoria	<u>Industrial Production (Operational Research)</u>

<b>No. of program lines</b> Anzahl Programmzeilen Nombre de lignes de programme N° di linee di programma	<u>334</u>	<b>No. of data registers</b> Anzahl des benötigten Datenspeicher Nombre de registres de données N° di registri utilizzati	$m^2 + m.n + 4m + 2n + 13$ <u>m=restrictions</u> <u>n=unknowns</u>
<b>Recommended HP 41C System configuration</b> Empfohlene System-Konfiguration Configuration recommandée Configurazione raccomandata	Port # 1 <u>memory module ?</u> Port # 2 <u>memory module ?</u> Port # 3 <u>memory module ?</u>	Port # 2 <u>memory module ?</u> Port # 4 <u>card reader</u>	

**This program requires the following programs as subroutines:**

Dieses Programm benutzt folgende Programme als Unterprogramme:  
 Ce programme utilise les programmes suivants comme sous-programmes:  
 Questo programma usa i seguenti programmi come subroutine:

**HP Applications ROM**

HP Applications ROM  
 ROM d'application HP  
 ROM di applicazione HP

**Program Name:**

Program:  
 Nom du programme:  
 Programma:

**Program Abstract**  
 Kurzbeschreibung  
 Brevue description  
 del programma  
Linear programming using the simplex method. The execution happens in 2 phases using a merge-instruction (card reader). This program is only restricted by the memory capacity available; it needs  $42+m^2+m.n+4m+2n+13$  registers (m=restrictions, n=unknowns). The program solves minimisations as well as maximisations. Except the required memory capacity Lin. Prog. I and Lin. Prog. II are identic.

<b>Name</b> Name/Nom/Name	<u>Lienart Xavier</u>		
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<b>Country</b> Land Pays Paese	<u>Belgium</u>		

**ACKNOWLEDGMENT AND AGREEMENT**  
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<b>Date</b> Datum Date Data	<u>22/10/80</u>	<b>Signature</b> Unterschrift Signature Firma	<u><i>X. Lienart</i></u>
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PROGRAMMBESCHREIBUNG I  
DESCRIPTION DU PROGRAMME I  
DESCRIZIONE DEL PROGRAMMA I

Application, Equations, Variables Anwendung, Gleichungen, Variablen Applicazione, Equazioni, Variabili	Explanation of the abbreviations: =====
RESTR? : How many restrictions?	
VAR? : How many unknowns?	
$X_{i,j}$ : $X_i$ of the $j^{th}$ restriction	
...>:0 : If the restriction is 'greater or equal' write 0	
If the restriction is 'smaller or equal' write any number but not 0	
R.S.i,0: Right-hand side of the $i^{th}$ restriction.	
CARD: Give the second part of the program.	
MAX=a MIN=b : If maximisation XEQa, if minimisation XEQb	
$X_i$ =...: The solution for $X_i$ is. ( $i \neq 0$ )	
$S_i$ =...: The rest of the $i^{th}$ restriction.	
$X_0$ =...: (rarely) This means that the restriction has not been used and that the rest is.... the same as with $S_i$ but without the number of the restriction.	
XX=...: The solution of the object-function	
Operating limits and Warnings Grenzen und Einschränkungen Limiti e restrizioni Limiti operativi e avvertenze	A test is incorporated in this program to verify if there are enough registers(memory) available to solve the problem. If you see NONEXISTENT after having given the number of restrictions, this means that you must extend the capacity using a size-instruction. If after the appearance of NONEXISTENT you execute $X \geq Y$ this gives you the number of the last required register. If you add 1 to this number this will give you the number of required registers ... the SIZE.

This program has been verified only with respect to the numerical example given in Program Description II. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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Le présent programme n'a été vérifié qu'en ce qui concerne l'exemple numérique indiqué dans la description du programme II. L'utilisateur accepte et utilise le présent programme À SES PROPRES RISQUES et doit se fier uniquement à sa propre inspection dudit programme sans se référer à toute autre déclaration et description.

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## PROGRAM DESCRIPTION II

PROGRAMMBESCHREIBUNG II  
DESCRIPTION DU PROGRAMME II  
DESCRIZIONE DEL PROGRAMMA II

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Example

Beispiel

Exemple

Esempio

$$\text{MAX } XX = 15X_1 + 45X_2$$

$$X_2 \leq 50$$

$$X_1 + 1.6X_2 \leq 240$$

$$0.5X_1 + 2X_2 \leq 162$$

$$X_1, X_2 \geq 0$$

Sketch

Skizze

Croquis

Schizzo



Line Zeile Ligne Linea	Keystrokes Tastentfidge Touches Tasti	Comments Kommentar Commentaires Commenti	Line Zeile Ligne Linea	Key pressed Tastentfidge Touches Tasti	Comments Kommentar Commentaires Commenti
01	STO 03		51	+	
	* LBL 10	Subroutine to		0	Are there enough memo- ry registers available.
	RCL 03	find the lo-		STO IND Y	
	INT	calisation of		RCL 10	
05	RCL 05	the restrictions		STO 03	
	*			* LBL 00	
	1,001			XE9 01	Read the X's
	*			CF IND 03	
	RCL 05			...>: 0	Sign of the
10	-		60	PROMPT	restriction.
	11,01			X=0?	
	+			SF IND 03	
	STO 06			RCL 03	Construction
	RTN			RCL 02	of the iden-
15	* LBL 06	Read the	65	+	tity matrix.
	MRG	second part		1	
	* LBL *LP			-	
	* LBL 03			1	
	CLRG			FS? IND 03	
20	r VAR ?	How may	70	CHS	
	PROMPT	variables?		STO IND Y	
	STO 00			RCL 01	
	r RESTR ?	How many		1,001	
	PROMPT	restrictions?		STO 07	
25	STO 01		75	*	
	3			ST + 02	
	10/X			r A.S.	
	/			ARCL 03	
	1			PROMPT	
30	+		80	STO IND 02	
	STO 10			RCL 07	
	11,01			ST + 02	
	STO 02			ISG 03	
	FIX 1			GTO 00	
35	RCL 00		85	CF 00	
	RCL 01			r MAR=a MIN=6	
	+			PROMPT	
	1			* LBL 01	Subroutine
	+			ARCL 00	to read the
40	STO 05	Length of a	90	3	X's.
	RCL 01	row		10/X	
	3			/	
	+			ST + 02	
	STO 03			RCL 03	
45	XE9 10		95	10	
	1			/	
	-			1	
	INT	Place of the		+	
	STO 09	nr. of the		STO 04	
50	RCL 00	restrictions	100	* LBL 02	

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PROGRAM LISTING  
 PROGRAMMAUFLISTUNG  
 LISTAGE DU PROGRAMME  
 LISTATO DI PROGRAMMA

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Line Zeile Ligne Linea	Keystrokes Tastentfolge Touches Tasti	Comments Kommentar Commentaires Commenti	Line Zeile Ligne Linea	Key pressed Tastentfolge Touches Tasti	Comments Kommentar Commentaires Commenti
A00	T X		A51	GTO 06	Go to the
	ARCL 04				Merge-instruction and read
	PROMPT				the second
	STO IND 02				part.
A05	1		55		
	ST + 04				
	ISG 02				
	GTO 02				
	RTN				
A10	x LBL 0	Max	60		
	SF 00				
	x LBL 0	Min			
	0				
	STO 03				
A15	XE9 01		65		
	ACL 00				
	ST - 02				
	x LBL 11	Change the			
	ACL IND 02	sign of the			
A20	CHS	object-function			
	STO IND 02				
	ISG 02				
	GTO 11				
	RCL 01				
A25	2		75		
	+				
	STO 03				
	XE9 10				
	STO 04				
A30	RCL 10		80		
	STO 03				
	x LBL 02				
	FC? IND 03				
	GTO 03	No M-factors			
A35	XE9 10		85		
	RCL 04				
	STO 02				
	x LBL 08	Fill up the			
	RCL IND 06	M-factors			
A40	6		90		
	107 X				
	*				
	ST + IND 02				
	RCL 02				
A45	ST + 02		95		
	ISG 06				
	GTO 08				
	x LBL 03				
	ISG 03				
A50	GTO 07		100		

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PROGRAM LISTING  
PROGRAMMAUFLISTUNG  
LISTAGE DU PROGRAMME  
LISTATO DI PROGRAMMA

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Line Zeile Ligne	Keystrokes Tastendruck Touches Tasti	Comments Kommentar Commentaires Commenti	Line Zeile Ligne	Key pressed Tastendruck Touches Tasti	Comments Kommentar Commentaires Commenti
01	x LBL L		51	-	
	RCL 01			STO 02	Number of the
	1			RCL 10	variable.
	+			STO 03	
05	STO 03		55	* LBL 13	Which variable
	XE 9 10			XE 9 00	leaves the
	-3			X > 0 ?	solution?
	10/X			GTO 09	
	ST-06			ISG 03	
10	0		60	GTO 13	
	STO 04			-X	There is no
	STO 07			PROMPT	solution.
	CF 01			LBL 08	
x	LBL 12	Which variable		STO 04	
15	RCL 06	enters the	65	RCL 03	
	RCL 05	solution?		STO 00	
	+		x	LBL 04	
	RCL 04			XE 4 00	
	RCL IND 06			X <= 0 ?	
20	RCL IND 2		70	GTO 03	
	FS? 00			RCL 04	
	CHS			X <= Y?	
	+			GTO 03	
	FS? 00			X < > Y	
25	CHS		75	STO 04	Variable lea-
	X <= 0 ?			RCL 03	ving the so-
	GTO 03			STO 00	lution and
	FS? 00			LBL 03	its number.
	CHS			ISG 03	
30	SF 01		80	GTO 04	
	X > Y ?			RCL 00	
	GTO 06			STO 03	
	FC? 00			RCL 08	Replace the
	GTO 03			+	old number b
35	* LBL 06		85	RCL 02	the number o
	STO 04			1	the new
	RCL 06			+	variable.
	STO 07			STO IND Y	
x	LBL 03			XE 9 10	
40	ISG 06		90	STO 07	
	GTO 12			RCL 02	
	FC? 01			+	
	GTO 06	If there is		RCL IND X	
	RCL 05	no entering		STO 04	
45	RCL 06	variable, go		LBL 01	
	RCL 07	to the end	95	RCL 04	Execute the
	-	and show the		ST/ IND 06	transformati
	INT	solution.		ISG 06	on the choos
	-			GTO 01	row.
50	1		100	RCL 01	

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Step Schritt Pas Passo	Instructions Operation Instructions Istruzioni	Variables Dateneingabe Données Dati	Function(s) Taste(n) Touche(s) Tasti	Result Resultat Risultato
1	Key in Program.			
2	Start Program.		XEQ LP	VAR ?
3	Key in the desired numbers.			RESTR ?
				...>.:0
				R.S.i,0
				MAX=a MIN=1
				Xi,0
4	Read the last cards.			Card
5	The solution of the program follows.			Working
	Perhaps the memory-capacity is too small; in this case execute the next steps:			
			XEQ LP	VAR ?
		4		RESTR ?
		3		NONEXISTENT
		XzY		54
		XEQ SIZE		SIZE ...
		SIZE 055		54
		XEQ LP		VAR ?
		4		RESTR ?
		3		XI,1
		...		...
		...		...
	If the program shows '-X' this means that there is no solution.			
	You can also avoid X0 in the solution by adding the following program lines after line 31	032	STO 03	
		033	LBL 09	
		034	RCL 09	
		035	RCL 03	
		036	+	
	If you have enough data registers available, this simplifies the lecture of the solution.	037	RCL 00	
		038	RCL 03	
		039	INT	
		040	+	
		041	STO IND Y	
		042	ISG 03	
		043	GTO 09	

[illegible]

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# REGISTERS, STATUS, FLAGS

## REGISTERBELEGUNG, FLAGS, BETRIEBSARTEN

### REGISTRES, INDICATEURS, MODES OPÉRATOIRES

#### REGISTRI, MODI OPERATIVI, FLAGS

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Registers Datenspeicher Registres de données Registri			Status Betriebsart Modes opératoires Modi operativi		
00	VAR in part I	50	Size $m^2 + 3m + 3n$ Total Reg. $m.n+13$ Size+42 User Mode		
	RESTR m		Eng <input type="checkbox"/>	Fix <input type="checkbox"/>	Sci <input type="checkbox"/>
	...		Deg <input type="checkbox"/>	Rad <input type="checkbox"/>	Grad <input type="checkbox"/>
	...		On <input checked="" type="checkbox"/>		
	...		Off <input type="checkbox"/>		
05	Number of columns		Purpose Bedeutung Signification Scopo		
	If you subtract n, you find		Flags SET CLEAR		
	(the location-1 of the dual		00	MAX or MIN	X => MAX
	...		01	Part I: If the	X => Part II: the
	Location-1 of the number of the		02	flag is set this	solution is
10	RESTR for ISG restrictions.		03	means that the	found.
	From here you find		04	restriction is	
	the matrix.		05	'smaller or equal'	
			06		
			07		
15		65	08		
			09		
			10		
			11	Audio execute	
			12		
20		70	13		
			14		
			15		
			16		
			17		
25		75	18		
			19		
			20		
			21	Printer Enable	
			22	Number Input	
30		80	23	Alpha Input	
			24	Range Ignore	
			25	Error Ignore	
			26	Audio Enable	
			27	User Mode	
35		85	28	Decimal Point	
			29	Digit Grouping	
			Assignments Tastenbelegung/Assignations/Assegnamenti		
40		90	Function Funktion Fonction Funzione	Key Taste Touche Tasto	Function Funktion Fonction Funzione
					Key Taste Touche Tasto
45		95			
		99			