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Decomposition matrices and Brauer trees of spin characters for S_{25} , p=17

Marwa M. Jawad

Department of Mathematics, College of Science, University of Basrah, Basrah, Iraq.

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ABSTRACT

In this paper, we will find the Brauer trees and the decomposition matrices of the symmetric groups S_n, when n=25 for p=17 by using (r,r')-inducing for calculates modular characters from the ordinary characters of the symmetric group.Also, we find all the blocks of defect 0 and 1 and we will depend on the results of the decomposition matrices of the symmetric groups S_n when n=24 for p=17 .

1. Introduction

The characters of the covering group of the symmetric group is said to be spin characters and the relation between the projective (ordinary) and the modular characters is called decomposition matrix . We want to calculate the modular characters from the ordinary characters of the symmetric group $\boldsymbol{S_n}$.

The graph connection of the irreducible ordinary characters in the block of defect one is called Brauer trees [1] .we will calculated the Brauer trees by use the decomposition matrices for the symmetric group .

Finally, we will find the Brauer trees and decomposition matrices for the symmetric group $\boldsymbol{S_{25}}$ mod 17 by dependence on [A. A. Yaseen , M. M. Jawad][2].

By using [3] , the degree of spin characters ‹α› , α= (α_1 , α_2 , … , α_n) is :

$$\deg\langle\alpha\rangle = 2^{\frac{n-m}{2}} \frac{n!}{\prod_{i=1}^{m} \alpha!} \prod_{1\le i<j\le m} \frac{(\alpha_i-\alpha_j)}{(\alpha_i+\alpha_j)} \qquad (1)$$

2. Brauer trees of spin characters for S_{25}

The Symmetric group $\boldsymbol{S_{25}}$ has 214 irreducible spin characters and 205 of (17,α)-regular classes, Then the decomposition matrix of the spin characters for $\boldsymbol{S_{25}}$, p =17 has 214 rows and 205 columns [4].

By using [3], there are 139 blocks of $\boldsymbol{S_{25}}$ six of them B_1 , B_2, B_3 ,B_4 , B_5 and B_6 of defect 1 and all the 139 remaining characters form their own blocks B_7 ,…, B_{139} of defect zero .

*Corresponding author email : marwa.jawad@uobasrah.edu.iq

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By using [5], we get in the principal block B_1, all the irreducible modular spin characters (i.m.s.) of the decomposition matrix are double and $<\beta> \neq <\beta>'$. The principle block B_1 contains the irreducible spin characters
{ ‹25›*, ‹17,8› ,‹17,8›$'$, ‹16,8,1›*, ‹15,8,2›*, ‹14,8,3›*, ‹13,8,4›*, ‹12,8,5›*,‹11,8,6›*,‹10,8,7›*} with 17-bar core <8>.

By using [5], we get in the principal block B_2, all the irreducible modular spin characters (i.m.s.) of the decomposition matrix are double and $<\beta>\neq <\beta>'$. The principle block B_2 contains the irreducible spin characters
{‹22,2,1›*, ‹19,5,1›*, ‹18,5,2›*, ‹17,5,2,1›, ‹17,5,2,1›$'$,‹14,5,3,2,1›*,‹13,5,4,2,1›*, ‹11,6,5,2,1›*,‹10,7,5,2,1›*,‹9,8,5,2,1›*} with 17-bar core <5,2,1>.

By using [5], we get in the principal block B_3, all the irreducible modular spin characters (i.m.s) of the decomposition matrix are double and $<\beta> \neq <\beta>'$.The principle block B_3 contains the irreducible spin characters
{ ‹21,3,1›*, ‹20,4,1›*,‹18,4,3›* , ‹17,4,3,1›, ‹17,4,3,1›$'$, ‹15,4,3,2,1›*, ‹12,5,4,3,1›*, ‹11,6,4,3,1›*, ‹10,7,4,3,1›*,‹9,8,4,3,1›*} with 17-bar core <4,3,1>.

By using [5], we get in the block B_4, all the irreducible modular spin characters (i.m.s.) of the decomposition matrix are associate and ‹β› ≠ ‹β›′. The block B_4 contains the irreducible spin characters { ‹24,1› , ‹24,1›$'$,‹18,7›,‹18,7›$'$, ‹17,7,1›*, ‹15,7,2,1› , ‹15,7,2,1›$'$, ‹14,7,3,1› , ‹14,7,3,1›$'$,‹13,7,4,1›, ‹13,7,4,1›$'$, ‹12,7,5,1›, ‹12,7,5,1›$'$, ‹11,7,6,1›, ‹11,7,6,1›$'$, ‹9,8,7,1›, ‹9,8,7,1›$'$} has 17-bar core <7,1>.

By using [5], we get in the block B_5 , all the irreducible modular spin characters (i.m.s) of the decomposition matrix are associate and ‹β› ≠ ‹β›′. The block B_5, contains the irreducible spin characters { ‹23,2› ,‹23,2›$'$, ‹19,6›, ‹19,6›$'$, ‹17,6,2›* , ‹16,6,2,1› ,‹16,6,2,1›$'$, ‹14,6,3,2›, ‹14,6,3,2›$'$, ‹13,6,4,2›, ‹13,6,4,2›$'$, ‹12,6,5,2›, ‹12,6,5,2›$'$, ‹10,7,6,2›, ‹10,7,6,2›$'$, ‹9,8,6,2› , ‹9,8,6,2›$'$ } has 17-bar core <6,2>.

By using [5], we get in the block B_6 , all the irreducible modular spin characters (i.m.s) of the decomposition matrix are associate and ‹β› ≠ ‹β›′. The block B_6, contains the irreducible spin characters { ‹22,3›,‹22,3›$'$,‹20,5›,‹20,5›$'$, ‹17,5,3›* , ‹16,5,3,1›,‹16,5,3,1›$'$,‹15,5,3,2› , ‹15,5,3,2›$'$, ‹13,5,4,3› , ‹13,5,4,3›$'$, ‹11,6,5,3›, ‹11,6,5,3›$'$, ‹10,7,5,3›,‹10,7,5,3›$'$,‹9,8,5,3›,‹9,8,5,3›$'$}has 17-bar core <5,3>.

Lemma (2.1.):

The Brauer tree for the block $\mathbf{B_1}$ is:

‹25›* − ‹17,8› = ‹17,8›$'$ − ‹16,8,1›* − ‹15,8,2›* −‹14,8,3›*−‹13,8,4›* − ‹12,8,5›* − ‹11,8,6›* −‹10,8,7›*

Proof :

By using [3,6], we get **:**

deg{ ‹25›* , ‹16,8,1›*, ‹14,8,3›* , ‹12,8,5›*, ‹10,8,7›*} ≡ 16 mod 17

deg{ ‹17,8› = ‹17,8›$'$, ‹15,8,2›*, ‹13,8,4›*, ‹11,8,6›*} ≡ −16 mod 17

By using (r, r')- inducing of the principal irreducible spin characters (p.i.s.) of $\boldsymbol{S_{24}}$ to $\boldsymbol{S_{25}}$ we have:

$d_{41}\uparrow^{(8,10)}S_{25} = D_1$

$d_{43}\uparrow^{(8,10)}S_{25} = D_2$

$d_{45}\uparrow^{(8,10)}S_{25} = D_3$

$d_{47}\uparrow^{(8,10)}S_{25} = D_4$

$d_{49}\uparrow^{(8,10)}S_{25} = D_5$

$d_{51}\uparrow^{(8,10)}S_{25} = D_6$

$d_{53}\uparrow^{(8,10)}S_{25} = D_7$

$d_{55}\uparrow^{(8,10)}S_{24} = D_8$

Table 1 : The decomposition matrix for this block $\mathbf{D_{25,17}}^{(1)}$

The spin characters	**The decomposition matrix of B_1**							
‹25›*	1							
‹17,8›	1	1						
‹17,8›'	1	1						
‹16,8,1›*		1	1					
‹15,8,2›*			1	1				
‹14,8,3›*				1	1			
‹13,8,4›*					1	1		
‹12,8,5›*						1	1	
‹11,8,6›*							1	1
‹10,8,7›*								1
	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8

Lemma (2.2.):

The Brauer tree for the block $\mathbf{B_2}$ is:

‹22,2,1›* − ‹19,5,1›* − ‹18,5,2›* −‹17,5,2,1› = ‹17,5,2,1›' −‹14,5,3,2,1›*−‹13,5,4,2,1›* − ‹11,6,5,2,1›* −‹10,7,5,2,1›* −‹9,8,5,2,1›*

Proof :

By using [3,6], we get **:**

deg{ ‹22,2,1›*, ‹18,5,2›* , ‹14,5,3,2,1›*, ‹11,6,5,2,1›*, ‹9,8,5,2,1›* } ≡ 9 mod 17;

deg{ ‹19,5,1›* , ‹17,5,2,1› = ‹17,5,2,1›', ‹13,5,4,2,1›*, ‹10,7,5,2,1›*}≡ −9 mod 17

By using (r, r')- inducing of the principal irreducible spin characters (p.i.s.) of $\boldsymbol{S_{24}}$ to $\boldsymbol{S_{25}}$ we have:

$d_{25}\uparrow^{(5,13)}S_{25} = D_9$

$d_{27}\uparrow^{(5,13)}S_{25} = D_{10}$

$d_{29}\uparrow^{(5,13)}S_{25} = D_{11}$

$d_{31}\uparrow^{(5,13)}S_{25} = D_{12}$

$d_{33}\uparrow^{(5,13)}S_{25} = D_{13}$

$d_{35}\uparrow^{(5,13)}S_{25} = D_{14}$

$d_{37}\uparrow^{(5,13)}S_{25} = D_{15}$

$d_{39}\uparrow^{(5,13)}S_{25} = D_{16}$

Table 2: The decomposition matrix for this block $\mathbf{D_{25,17}}^{(2)}$

The spin characters	The decomposition matrix of B_2							
‹22,2,1›*	1							
‹19,5,1›*	1	1						
‹17,5,2,1›*		1	1					
‹17,5,2,1›			1					
‹17,5,2›'			1	1				
‹14,5,3,2,1›*				1	1			
‹13,5,4,2,1›*				1	1	1		
‹11,6,5,2,1›*						1	1	
‹10,7,5,2,1›*							1	1
‹9,8,5,2,1›*								1
	D_9	D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}	D_{16}

Lemma (2.3.):

The Brauer tree for the block $\mathbf{B_3}$ is:

‹21,3,1›* − ‹20,4,1›* − ‹18,4,3›* −‹17,4,3,1› = ‹17,4,3,1›' −‹15,4,3,2,1›*−‹12,5,4,3,1›* −‹11,6,4,3,1›* − ‹10,7,4,3,1›* −‹9,8,4,3,1›*

Proof :

By using [3,6], we get **:**

deg{ ‹21,3,1›*, ‹18,4,3›*, ‹15,4,3,2,1›* , ‹11,6,4,3,1›* , ‹9,8,4,3,1›*} ≡ 11 mod 17;

deg{ ‹20,4,1›*, ‹17,4,3,1› = ‹17,4,3,1›', ‹12,5,4,3,1›*, ‹10,7,4,3,1›*}≡ −11 mod 17

By using (r, r')- inducing of the principal irreducible spin characters (p.i.s.) of $\boldsymbol{S_{24}}$ to $\boldsymbol{S_{25}}$ we have:

$d_{17}\uparrow^{(0,1)}S_{24} = D_{17}$

$d_{27}\uparrow^{(3,15)}S_{24} = D_{18}$

$d_{29}\uparrow^{(3,15)}S_{24} = D_{19}$

$d_{31}\uparrow^{(3,15)}S_{24} = D_{20}$

$d_{33}\uparrow^{(3,15)}S_{24} = D_{21}$

$d_{35}\uparrow^{(3,15)}S_{24} = D_{22}$

$d_{37}\uparrow^{(3,15)}S_{24} = D_{23}$

$d_{39}\uparrow^{(3,15)}S_{24} = D_{24}$

Table 3: The decomposition matrix for this block $\mathbf{D_{25,17}}^{(3)}$

The spin characters	**The decomposition matrix of B₃**							
‹21,3,1›*	1							
‹20,4,1›*	1	1						
‹18,4,3›*		1	1					
‹17,4,3,1›			1					
‹17,4,3,1,›'			1	1				
‹15,4,3,2,1›*				1	1			
‹12,5,4,3,1›*				1	1	1		
‹11,6,4,3,1›*						1	1	
‹10,7,4,3,1›*							1	1
‹9,8,4,3,1›*								1
	D_{17}	D_{18}	D_{19}	D_{20}	D_{21}	D_{22}	D_{23}	D_{24}

Lemma (2.4.):

The Brauer tree for the block $\mathbf{B_4}$ is:

‹24,1› −‹18,7› ╲ ╱‹15,7,2,1› − ‹14,7,3,1› − ‹13,7, 4,1› − ‹12,7,5,1› − ‹11,7,6,1› − ‹9,8,7,1›

‹17,7,1›*

‹24,1›'− ‹18,7›' ╱ ╲ ‹15,7,2,1›' − ‹14,7,3,1›' − ‹13,7,4,1›' − ‹12,7,5,1›' − ‹11,7,6,1›' − ‹9,8,7,1›'

Proof :

By using [3,6], we get **:**

deg{ ‹24,1› , ‹24,1›' , ‹17,7,1›*, ‹14,7,3,1› , ‹14,7,3,1›' , ‹12,7,5,1› , ‹12,7,5,1›', ‹9,8,7,1› , ‹9,8,7,1›'} ≡ 14 mod 17;

deg{‹18,7›, ‹18,7›', ‹15,7,2,1› , ‹15,7,2,1›' , ‹13,7, 4,1› ,‹13,7,4,1›', ‹11,7,6,1›, ‹11,7,6,1›'›'} ≡ −14 mod 17

By using (r, r')- inducing of the principal irreducible spin characters (p.i.s.) of $\boldsymbol{S_{24}}$ to $\boldsymbol{S_{25}}$ we have:

$d_1\uparrow^{(7,11)}S_{25} = K_1 = D_{25} + D_{26}$

$d_2\uparrow^{(7,11)}S_{25} = K_2 = D_{27} + D_{28}$

$d_{45}\uparrow^{(0,1)}S_{25} = D_{29}$, $d_{46}\uparrow^{(0,1)}S_{25} = D_{30}$

$d_{47}\uparrow^{(0,1)}S_{25} = D_{31}$, $d_{48}\uparrow^{(0,1)}S_{25} = D_{32}$

$d_{49}\uparrow^{(0,1)}S_{25} = D_{33}$, $d_{50}\uparrow^{(0,1)}S_{25} = D_{34}$

$d_{51}\uparrow^{(0,1)}S_{25} = D_{35}$, $d_{52}\uparrow^{(0,1)}S_{25} = D_{36}$
$d_{53}\uparrow^{(0,1)}S_{25} = D_{37}$, $d_{54}\uparrow^{(0,1)}S_{25} = D_{38}$
$d_{55}\uparrow^{(0,1)}S_{25} = D_{39}$, $d_{56}\uparrow^{(0,1)}S_{25} = D_{40}$
Since ‹24,1› ≠ ‹24,1›' on (17, α)-regular classes then K_1 is split to D_{25} and D_{26}
<18,7,1> $\downarrow_{(0,1)}S_{25}$ = <18,7> + <17,7,1>* =D_{27}. Since <18,7,1> i.m.s in $\boldsymbol{S_{26}}$.
<18,7,1>′$\downarrow_{(0,1)}S_{25}$ = <18,7>′ + <17,7,1>* =D_{28}. Since <18,7,1>′ i.m.s in $\boldsymbol{S_{26}}$.
Then K_2 split to D_{27} and D_{28}.

Table 4 : The decomposition matrix for this block $\mathbf{D_{25,17}}$ **(4)**

The spin characters	The decomposition matrix of B_4															
‹24,1›																
‹24,1›'																
‹18,7›																
‹18,7›′																
‹17,7,1›*																
‹15,7,2,1›																
‹15,7,2,1›′																
‹14,7,3,1›																
‹14,7,3,1›′																
‹13,7,4,1›																
‹13,7,4,1›′																
‹12,7,5,1›																
‹12,7,5,1›′																
‹11,7,6,1›																
‹11,7,6,1›′																
‹9,8,7,1›																
‹9,8,7,1›′																
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Lemma (2.5.):

The Brauer tree for the block $\mathbf{B_5}$ is:

‹23,2› −‹19,6› ╲ ╱ ‹16,6,2,1› − ‹14,6,3,2› − ‹13,6,4,2› − ‹12,6,5,2› − ‹10,7,6,2› − ‹9,8,6,2›
‹17,6,2›*
‹23,2›′− ‹19,6›′ ╱ ╲ ‹16,6,2,1›′ − ‹14,6,3,2›′ − ‹13,6,4,2›′ − ‹12,6,5,2›′ − ‹10,7,6,2›′ − ‹9,8,6,2›′

Proof :

By using [3,6], we get **:**

deg{ ‹23,2›, ‹23,2›′, ‹17,6,2›*, ‹14,6,3,2› , ‹14,6,3,2›′, ‹12,6,5,2›, ‹12,6,5,2›′, ‹9,8,6,2›, ‹9,8,6,2›′} ≡ 10 mod 17;
deg{ ‹19,6›, ‹19,6›′, ‹16,6,2,1›, ‹16,6,2,1›′, ‹13,6,4,2›, ‹13,6,4,2›′, ‹10,7,6,2› , ‹10,7,6,2›′} ≡ −10 mod 17

By using (r, r') - inducing of the principal irreducible spin characters (p.i.s.) of $\boldsymbol{S_{24}}$ to $\boldsymbol{S_{25}}$ we have:

$d_1\uparrow^{(2,16)}S_{25} = K_3 = D_{41} + D_{42}$
$d_2\uparrow^{(2,16)}S_{25} = K_4 = D_{43} + D_{44}$
$d_3\uparrow^{(2,16)}S_{25} = K_5 = D_{45} + D_{46}$
$d_4\uparrow^{(2,16)}S_{25} = K_6 = D_{47} + D_{48}$
$d_5\uparrow^{(2,16)}S_{25} = K_7 = D_{49} + D_{50}$
$d_6\uparrow^{(2,16)}S_{25} = K_8 = D_{51} + D_{52}$
$d_7\uparrow^{(2,16)}S_{25} = K_9 = D_{53} + D_{54}$
$d_8\uparrow^{(2,16)}S_{25} = K_{10} = D_{55} + D_{56}$

Since ‹23,2› ≠ ‹23,2›′ , ‹19,6›≠ ‹19,6›′ , ‹16,6,2,1›≠ ‹16,6,2,1›′ , ‹14,6,3,2› ≠ ‹14,6,3,2›′ , ‹13,6,4,2› ≠ ‹13,6,4,2›′, ‹12,6,5,2› ≠ ‹12,6,5,2›′ , ‹10,7,6,2› ≠ ‹10,7,6,2›′ , ‹9,8,6,2› ≠ ‹9,8,6,2›′ on (17, α)-regular classes, then K_3 , K_4 , K_5 , K_6 , K_7 , K_8 , K_9 and K_{10} are split respectively .

Table 5: The decomposition matrix for this block $\mathbf{D_{25,17}}$ **(5)**

The spin characters	The decomposition matrix of B_5														
‹23,2›															
‹23,2›′	1														
‹19,6›		1													
‹19,6›′	1		1												
‹17,6,2›*		1	1	1	1										
‹16,6,2,1›				1		1									
‹16,6,2,1›′					1		1								
‹14,6,3,2›						1		1							
‹14,6,3,2›′							1		1						
‹13,6,4,2›								1		1					
‹13,6,4,2›′									1		1				
‹12,6,5,2›										1		1			
‹12,6,5,2›′											1		1		
‹10,7,6,2›												1		1	
‹10,7,6,2›′													1		1
‹9,8,6,2›														1	
‹9,8,6,2›′															1
	D_{42}	D_{43}	D_{44}	D_{45}	D_{46}	D_{47}	D_{48}	D_{49}	D_{50}	D_{51}	D_{52}	D_{53}	D_{54}	D_{55}	D_{56}

Lemma (2.6.):

The Brauer tree for the block $\mathbf{B_6}$ is:

‹22,3› −‹20,5› ╲ ╱ ‹16,5,3,1› − ‹15,5,3,2› − ‹13,5,4,3› − ‹11,6,5,3› − ‹10,7,5,3› − ‹9,8,5,3›
‹17,5,3›*
‹22,3›′− ‹20,5›′ ╱ ╲ ‹16,5,3,1›′ − ‹15,5,3,2›′ − ‹13,5,4,3›′ − ‹11,6,5,3›′ − ‹10,7,5,3›′ − ‹9,8,5,3›′

Proof :

By using [3,6], we get **:**

deg{ ‹22,3›, ‹22,3›′, ‹17,5,3›*,‹15,5,3,2› ,‹15,5,3,2›′ ,‹11,6,5,3› ,‹11,6,5,3›′,‹9,8,5,3›,‹9,8,5,3›′}≡ 10 mod 17;

deg{ ‹20,5›, ‹20,5›′ , ‹16,5,3,1› , ‹16,5,3,1›′, ‹13,5,4,3› , ‹13,5,4,3›′, ‹10,7,5,3› , ‹10,7,5,3›′ } ≡ −10 mod 17

By using (r,r′)- inducing of the principal irreducible spin characters (p.i.s.) of $\boldsymbol{S_{24}}$ to $\boldsymbol{S_{25}}$ we have:

$d_9\uparrow^{(3,15)}S_{25} = K_{11} = D_{57} + D_{58}$
$d_{10}\uparrow^{(3,15)}S_{25} = K_{12} = D_{59} + D_{60}$
$d_{11}\uparrow^{(3,15)}S_{25} = K_{13} = D_{61} + D_{62}$
$d_{12}\uparrow^{(3,15)}S_{25} = K_{14} = D_{63} + D_{64}$
$d_{13}\uparrow^{(3,15)}S_{25} = K_{15} = D_{65} + D_{66}$
$d_{14}\uparrow^{(3,15)}S_{25} = K_{16} = D_{67} + D_{68}$
$d_{15}\uparrow^{(3,15)}S_{25} = K_{17} = D_{69} + D_{70}$
$d_{16}\uparrow^{(3,15)}S_{25} = K_{18} = D_{71} + D_{72}$

Since ‹22,3›≠ ‹22,3›′ ,‹20,5›≠ ‹20,5› ,‹16,5,3,1›≠ ‹16,5,3,1›′ , ‹15,5,3,2› ≠ ‹15,5,3,2› , ‹13,5,4,3›≠ ‹13,5,4,3›′, ‹11,6,5,3›≠ ‹11,6,5,3›′ , ‹10,7,6,2›≠ ‹10,7,6,2›′ , ‹9,8,5,3›≠ ‹9,8,5,3› on (17, α)-regular classes, then K_{11} , K_{12} , K_{13} , K_{14} , K_{15} , K_{16} , K_{17} and K_{18} are split respectively .

Table 6 : The decomposition matrix for this block $\mathbf{D_{25,17}}$ **(6)**

The spin characters	**The decomposition matrix of B6**													
	I_{58}	I_{59}	I_{60}	I_{61}	I_{62}	I_{63}	I_{64}	I_{65}	I_{66}	I_{67}	I_{68}	I_{69}	I_{70}	I_{71}
‹22,3›														
‹22,3›′	1													
‹20,5›		1												
‹20,5›′	1		1											
‹17,5,3›*		1	1	1	1									
‹16,5,3,1›				1		1								
‹16,5,3,1›′					1		1							
‹15,5,3,2›						1		1						
‹15,5,3,2›′							1		1					
‹13,5,4,3›								1		1				
‹13,5,4,3›′									1		1			
‹11,6,5,3›										1		1		
‹11,6,5,3›′											1		1	
‹10,7,5,3›												1		1
‹10,7,5,3›′													1	
‹9,8,5,3›														1
‹9,8,5,3›′														

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مصفوفات التجزئة وأشجار براور للمشخصات الاسقاطية ل S_{25} و P=17

مروى محمد جواد

قسم الرياضيات، كلية العلوم، جامعة البصرة، البصرة، العراق.

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الملخص

في هذا البحث سوف نقوم بإيجاد أشجار براور ومصفوفات التجزئة للزمر التناظرية S_n عندما n=25, p=17 باستخدام (r,r') المولدة لحساب المشخصات الاسقاطية من المشخصات العادية للزمر التناظرية كذلك سوف نقوم بإيجاد كل القطع من النوع 1 و0 بالاعتماد على نتائج مصفوفات التجزئة للزمر التناظرية S_n عندما p=17 n=24 .

*Corresponding author email : marwa.jawad@uobasrah.edu.iq

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